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Rev. 0

100-B/C Area Ecological Risk Assessment Data Quality Objectives

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Signature Date

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100-B/C Area Ecological Risk Assessment Data Quality Objectives

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TABLE OF CONTENTS

APPENDIX

FIGURES

TABLES

ACRONYMS

AA	alternative action
AEA	alpha energy analysis
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
BCG	biota concentration guide
BHI	Bechtel Hanford, Inc.
CAS	Chemical Abstract Services
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CHI	CH2M Hill Hanford, Inc.
COC	contaminant of concern
COPC	contaminant of potential concern
CVAA	cold vapor atomic absorption
CVP	cleanup verification package
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GC	gas chromatograph
GCMS	gas chromatograph/mass spectrometry
GEA	gamma energy analysis
GPC	gas proportional counter
GPS	global positioning system
HAB	Hanford Advisory Board
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma/mass spectrometry
LFI	limited field investigation
MLS	multiple level sampling
MTCA	*Model Toxics Control Act*
NEPA	*National Environmental Policy Act of 1969*
NPL	National Priorities List
N/A	not applicable
OU	operable unit
PCB	polychlorinated biphenyl
PNNL	Pacific Northwest National Laboratory
PQL	practical quantitation limit
PRG	preliminary remediation goal

Acronyms

PSQ	preliminary study question
PSRPP	Public Safety and Resource Protection Program
RAG	remedial action goal
RDR/RAWP	remedial design report/remedial action work plan
RESRAD	RESidual RADioactivity (dose model)
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
SAP	sampling and analysis plan
SVOA	semi-volatile organic analyte
TBC	to be considered
TBD	to be determined
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence limit
USFWS	U.S. Fish and Wildlife Service
VOA	volatile organic analyte
WAC	*Washington Administrative Code*

METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

1.0 STEP 1 – STATE THE PROBLEM

The purpose of this data quality objective (DQO) process is to define the scope and data needs to support a pilot baseline risk assessment of the remedial actions at the 100-B/C Area of the Hanford Site.

1.1 INTRODUCTION

When the B and C Reactors were operating, the majority of the reactor cooling water containing radionuclides and minor amounts of organic and inorganic chemicals was discharged to the Columbia River. Smaller waste streams containing higher concentrations of contaminants were discharged to liquid waste disposal cribs and trenches. Solid wastes were buried in separate unlined trenches. These releases, as well as leaks in the various buried pipes and basins, resulted in contamination of the soil, the groundwater, and the Columbia River.

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998) includes a site characterization and remediation strategy for the 100 Areas that addresses the reactors, auxiliary buildings, planned and unplanned waste sites, and groundwater. The strategy is based on a bias-for-action concept that allows remediation and site characterization to proceed in tandem. The bias-for-action concept focuses on cleanup of the contaminated soil and waste sites that could contribute to future groundwater contamination. Interim Records of Decision (RODs) authorize the remedial action. The auxiliary buildings will be decontaminated and demolished. The reactor buildings will be decontaminated and demolished except for the graphite reactor cores, which are considered to be too radioactive to deal with at present. The reactor cores will be placed in interim safe storage and addressed within 75 years (58 *Federal Register* 48509). With the cessation of reactor operations, the contaminant contributions to groundwater in the 100 Areas continue to decrease.

The remediation of wastes sites in the 100 Areas was prioritized so the sites having the highest potential impact to groundwater, sites closest to the Columbia River, and sites that contributed the most to surface radiation exposure would be remediated first. Some lower priority sites were included in the initial phase because of their close proximity to the high-priority sites. The next phase of remediation is currently planned to occur in two stages: (1) the burial grounds and (2) the Remaining Sites. The burial grounds are solid waste sites that received contaminated materials such as equipment, used parts, and construction debris from reactor operations activities. These sites were assigned a lower priority for remediation than the liquid sites because contamination is generally fixed in the solid waste materials and has little potential to affect groundwater. The Remaining Sites are the lowest priority sites because they represent the least potential risk to human health and the environment. They include septic systems, burn pits, and buildings that were demolished in situ under the decontamination and decommissioning program.

After all near-term Tri-Party Agreement remediation activities are completed, the 100-B/C reactor area will consist of remediated waste sites that have been backfilled and revegetated, as well as reactors that have been placed into interim safe storage. Active facilities that remain will support ongoing Hanford Site activities (e.g., the 181-B Pump House, 182-B Water Treatment Plant, and export water lines). Additionally, uncontaminated infrastructures will remain, such as paved and gravel roads, building foundations, telephone and power lines, and fences.

As part of the focused feasibility studies for the 100 Area source operable units (OUs), the removal/treatment/disposal remediation alternative was selected. Interim action RODs were developed by the controlling regulatory agencies for the high-priority liquid waste disposal sites, burial grounds, and remaining sites. Subsequent remedial design reports/remedial action work plans (RDR/RAWPs) were developed to better define the means and methods of the required remedial actions.

The purpose of this DQO process and pilot study is to begin the process of evaluating the effectiveness of the remedial action projects for protecting human health and the environment. Evaluation of potential human and ecological impacts and risks is an important element in reaching final remediation and closure decisions for contaminated waste sites. This pilot risk assessment will assess the protectiveness of cleanup actions for human health and ecological resources within the area affected by the remediated waste sites in the 100-B/C Area.

The purpose of this DQO summary report is as follows:

- Evaluate the current list of contaminants of concern (COCs) for completeness.
- Identify all exposure pathways to potential human and ecological receptors within the bounds of the 100-B/C pilot study area.
- Identify sentinel and indicator species that would be used for biological monitoring.
- Identify appropriate models and methods to evaluate risk to human and ecological receptors.
- Identify data gaps.
- Identify data quality and collection activities needed to fill data gaps.
- Provide the basis and rationale for a human and ecological health sampling design.

This DQO evaluation will assess the adequacy of existing data and includes the collection of supplementary biotic and abiotic data to support *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) requirements, including the natural resource damage assessment process (43 *Code of Federal Regulations* [CFR] 11), as appropriate. The results of the data collection and evaluation process will be used to evaluate remedial action effectiveness in reducing or eliminating human and ecological risks (e.g., breaking exposure pathways) and may also be used to refine remedial action objectives.

1.2 PROJECT OBJECTIVES

The objective of the 100-B/C pilot study DQO summary report is to begin the process of evaluating the site conditions following remediation and to determine the environmental measurements necessary to assess protectiveness of the remedial actions. This DQO summary report will support the development of a sampling and analysis plan (SAP) to obtain additional data.

It is expected that this will be a two-phase study. This DQO process and the sampling design represent the first phase. The field data and sampling design will be evaluated and may be supplemented with a second phase, if necessary. The evaluation will also consider the need for periodic or long-term adjustments.

1.3 DATA QUALITY OBJECTIVE TEAM MEMBERS AND KEY DECISION MAKERS

Individual members of the DQO team were carefully selected to participate in the seven-step DQO process based on their technical background, site history, and expertise in the areas needed to meet the task objectives. The key decision makers included representatives from the U.S. Department of Energy (DOE), Washington State Department of Ecology (Ecology), and U.S. Environmental Protection Agency (EPA), Region 10. The role of the key decision makers was to make final decisions related to the scope and sampling design.

Tables 1-1 and 1-2 identify the members of the DQO team and the key decision makers, respectively. These tables also identify the organization that each DQO team member or key decision maker represents, as well as their technical area of expertise.

Table 1-1. DQO Team Members. (2 Pages)

Name	Organization	Role and Responsibility
Pam Doctor	BHI Natural Resources and Environmental Site Closure	Project Lead
Ken Gano	BHI Natural Resources and Environmental Site Closure	Project Lead
Roy Bauer	Fluor Hanford, Inc.	DQO Facilitator

Table 1-1. DQO Team Members. (2 Pages)

Name	Organization	Role and Responsibility
Jenifer Linville	CHI Regulatory Sciences	Technical Staff
Jessica Kious	BHI Natural Resources and Environmental Site Closure	Technical Staff
Roger Ovink	CHI Regulatory Sciences	Technical Staff
Barry Vedder	BHI Regulatory Support	Regulatory Support
Rich Weiss	CHI Sample/Data Management	Radiochemical and Analytical
Ted Poston	PNNL PSRPP	Technical Support
Brett Tiller	PNNL PSRPP	Technical Support
Janelle Downs	PNNL PSRPP	Technical Support
Greg Patton	PNNL PSRPP	Technical Support
Mike Ritter	USFWS	Technical Consultant

BHI = Bechtel Hanford, Inc.
CHI = CH2M Hill Hanford, Inc.
PNNL = Pacific Northwest National Laboratory
PSRPP = Public Safety and Resource Protection Program
USFWS = U.S. Fish and Wildlife Service

Table 1-2. DQO Key Decision Makers.

Name	Organization	Role and Responsibility
Beth Bilson	DOE	Assistant Manager for the River Corridor
Chris Smith	DOE	Project Manager
John Price	Ecology	Project Manager
Dennis Faulk	EPA	Project Manager

1.4 MILESTONE DATES

A Tri-Party Agreement commitment (Ecology et al. 1998) was established for completion of the 100-B/C pilot study by July 29, 2005. The information in this DQO summary report and any subsequent sampling data will be used to support the Tri-Party Agreement commitment. Table 1-3 presents the tentative schedule for completion of the task activities associated with the 100-B/C Pilot study.

Table 1-3. Milestone Dates.

Task Activities	Milestone Date
DQO workbook development	08/01/02 to 02/11/03
SAP development	11/08/02 to 03/19/03
Sampling (round 1)	03/21/03 to 12/15/03
Analyze and review sampling data	04/18/03 to 12/31/03
Develop Native American scenarios	11/15/02 to 09/30/03
Sampling (round 2)	03/22/04 to 11/15/04
Analyze and review sampling data	04/19/04 to 11/15/04
Data quality assessment	03/21/03 to 11/15/04
Prepare risk assessment report	01/03/05 to 07/25/05
Issue final risk assessment report to DOE	07/29/05

1.5 PROJECT ISSUES

Project issues include the global issues that transcend the specific DQO process and also the technical issues that are unique to the project. Both the global and the project technical issues have the potential to impact the sampling design or the DQOs for the project.

1.5.1 Trustee and Hanford Advisory Board Interview Issues

To help focus the scope of the 100-B/C pilot study, the project team provided briefings of the general scope, followed by interviews with representatives of the Hanford Natural Resource Trustees and the Hanford Advisory Board (HAB). Table 1-4 contains the interview issues identified by representatives of the Trustees and HAB. Decision-maker responses and positions are also presented in the table. The information in this table supported the scope definition for this DQO process and pilot study. The interviewees that identified these issues during the interview process are included in Appendix A, Table A-1 of this DQO summary report.

Table 1-4. Interview Issues Matrix. (11 Pages)

#		Interview Issues	Accept?	Comment Resolution
Political				
1.		Use team approach with USFWS for setting standards	Y	RL has invited USFWS to participate in the process.
2.		Discuss management of the monument with USFWS at the regional level, not just the local level	N	Management of the monument will be documented in the comprehensive conservation plan to be prepared by USFWS.
3.		Uses of land under "Monument"		Management of the monument will be documented in the comprehensive conservation plan to be prepared by USFWS.
4.		Risk assessment process		
	a.	List known toxicity impacts/mechanisms/ effects of COCs to ecological receptors	Y	Known toxic impacts/mechanisms/effects of COCs will be evaluated in the risk assessment.
	b.	Integrate the eight step EPA risk assessment methodology with new WAC 173-340-7490 ecological evaluation procedures and include site-specific sampling		The WAC 173-340-7490 ecological evaluation procedures were developed from the EPA methodology and in cooperation with EPA. An initial step in an ecological risk assessment is the ecological screening assessment, which will be implemented in the pilot study.
	c.	Define ecological assessment and measurement endpoints (i.e., look for health of the aquatic environment using some measurement endpoints defined by expert team [USFWS and National Marine Fisheries Service])		Assessment and measurement endpoints will be defined in the pilot study.
5.		Experimental information is needed to fill data gaps		This pilot study will identify measurement and assessment endpoints that are designed to fill data gaps.
6.		Use a holistic evaluation process		The pilot study will identify and evaluate ecological systems within the boundaries of the study.
7.		Discuss public involvement		This pilot study will ultimately feed into a CERCLA FS. "Community acceptance" is a balancing criterion for evaluating remedial alternatives in the FS. The Tri-Parties have developed a draft public involvement plan and will be working with a Hanford Public Involvement Committee. Thus, an active campaign of public information will be carried on during the pilot study.

Table 1-4. Interview Issues Matrix. (11 Pages)

#		Interview Issues	Accept?	Comment Resolution
Protectiveness				
8.	Need for Native American exposure scenarios			
	a.	Protectiveness for Native American use and treaty rights	Y	Native American exposure scenarios will be developed in cooperation with Tribes and existing literature to assess risk to Native Americans. The results will provide input for the preparation of a final ROD.
	b.	Herb sites		
	c.	Vegetation – food		
	d.	Vegetation – medicine		
	e.	Culturally sensitive areas		Native American exposure scenarios will be developed in cooperation with Tribes and existing literature to assess risk to Native Americans. The results will provide input for the preparation of a final ROD.
	f.	Long-term effect of radionuclides on Native American lifestyle		
	g.	Spring water sources for Sweat Lodges		
	h.	Fish consumption		
	i.	Evaluate treaty protected species		
	j.	Native American use categories		
	k.	River use and associated consumption (include women and children)		
	l.	Protection of human health and ecological receptors now and for future generations		
	m.	Evaluate Native American exposure pathways by others (tank retrieval performance evaluation study by Jacobs Engineering)		
9.	Recreational scenario (Monument access, camping, shoreline use; include children, recreational worker, and unique child dose response)			A recreational scenario will be addressed in the pilot study to assess risk to the recreational visitor. The results will provide input for preparation of a final ROD.
10.	Use MTCA human health risk assumptions			The MTCA human health risk assumptions will be addressed in the pilot study.
11.	Assumptions			
	a.	Define boundary of the assessment and address the entire area within the boundary, including portions not remediated	N	The pilot study will define the boundary of the assessment as the high-priority liquid waste sites in the 100-B/C Area OUs, the riparian zone, and the near-shore environment.
	b.	Define groundwater use	Y	Groundwater use will be defined in the pilot project pilot study in support of exposure scenario development.

Table 1-4. Interview Issues Matrix. (11 Pages)

<table>
<tr><th>#</th><th colspan="2">Interview Issues</th><th>Accept?</th><th>Comment Resolution</th></tr>
<tr><td rowspan="7"></td><td>c.</td><td>Catastrophic river flood</td><td>N</td><td>Catastrophic floods have the potential to destroy the riparian zone and aquatic ecology for extended time periods, mainly due to physical and hydraulic disturbances. Radiological and chemical impacts would be insignificant in comparison with the catastrophic flood. Probable maximum flood events were considered in Decommissioning of Eight Surplus Production Reactors at Hanford Site Addendum (DOE 1992) and will not be re-evaluated in this effort.</td></tr>
<tr><td>d.</td><td>Constrain the project to credible events</td><td rowspan="3">Y</td><td>The exposure scenarios will define the parameters to be evaluated.</td></tr>
<tr><td>e.</td><td>Determine ecological risk for upland, riparian, and near-shore aquatic zones</td><td>This is consistent with current scope.</td></tr>
<tr><td>f.</td><td>• Evaluate certain sites/areas in risk evaluation
• Liquid waste discharge sites
• Leaks along pipelines
• Seeps
• Residual tritium from targets
• Burial ground wastes and capsules
• "Hot spots" (site should be characterized)</td><td>Residual contamination will be evaluated for complete exposure pathways and the risk evaluated.</td></tr>
<tr><td>g.</td><td>Residual contamination; unused areas (airborne deposits)</td><td>N</td><td>Residual contamination will include waste sites within the 100-B/C Area OUs and shoreline. This does not include unused areas within the 100-B/C Area.</td></tr>
<tr><td>h.</td><td>Overland flows from operational upsets</td><td rowspan="2">Y</td><td>Records of spills, leaks, and soil percolation have been addressed in the remedial action and documented, none of which have resulted in unplanned overland flows to the river. Outfall spillways and discharge pipelines are identified and have been (or will be) remediated as part of the 100-B/C remedial action.</td></tr>
<tr><td>i.</td><td>• Define terms in the pilot study timeframes (0 to 150, 150 to 500, 500+ years)
• Zones
• Reference case
• Monument</td><td>Risk will be evaluated for time periods and stop at 1,000 years. Terminology will be defined in this workbook. Timeframes will be developed as the pilot study proceeds.</td></tr>
</table>

Table 1-4. Interview Issues Matrix. (11 Pages)

#		Interview Issues	Accept?	Comment Resolution
12.	Global issues			
	a.	Future groundwater impacts from 200 Areas	N	The assessment will identify links to external systems (e.g., Columbia River) and will attempt to identify critical imports and exports from external systems. Future potential impacts from 200 Area sources will be addressed by the 200 Area processes.
	b.	*Long-term stewardship*	N	*This is beyond the scope of the pilot study.*
	c.	15 mrem/yr radiological criteria are not conservative enough	N	The 15 mrem/yr radiological criteria have been accepted by the decision makers in the ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 OUs.
	d.	95% UCL not adequate for Native American scenario	N	The UCL of the mean is the statistical parameter of interest for closure of waste sites in accordance with EPA guidance and MTCA.
	e.	Legal recourse for natural resource damages through the natural resource damage assessment	N	All residual contamination will be evaluated for complete exposure pathways and the risk evaluated. Legal recourse issues are beyond the scope of this pilot study.
	f.	Ensure that contaminated soils beneath reactor buildings will be addressed after remediation	N	Reactor buildings are not included in the CERCLA RODs for the 100-B/C Area and therefore are not within the scope of the pilot study.
	g.	EPA "hot spot" size not appropriate for Native American uses	Y	This issue will be addressed during the pilot study.
13.	For ecological protectiveness, use site-specific cleanup criteria for COC elimination, not only MTCA tables		Y	The pilot study will use a site-specific weight of evidence approach to determine if the COC cleanup criteria are protective of ecological receptors.
Ecological RAGs				
14.	Ecological RAGs			
	a.	Revisit process for setting ecological RAGs	N	The pilot study includes the basis for documenting project criteria.
	b.	Evaluate AWQC for protection of all aquatic species	N	AWQC were developed for this purpose and are accepted as ARARs in the ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 OUs.

Table 1-4. Interview Issues Matrix. (11 Pages)

<table>
<tr><th>#</th><th colspan="2">Interview Issues</th><th>Accept?</th><th>Comment Resolution</th></tr>
<tr><td colspan="5">Pathways</td></tr>
<tr><td>15.</td><td colspan="2">Use shrub/steppe habitat assessment for uplands</td><td>Y</td><td>Terrestrial ecological exposure scenarios will be based on resident upland habitat types and species.</td></tr>
<tr><td rowspan="7">16.</td><td colspan="4">Include groundwater</td></tr>
<tr><td>a.</td><td>Assess commingling of groundwater plumes</td><td rowspan="6">Y</td><td rowspan="6">The pilot study will address exposure scenarios related to groundwater use based on current conditions. It will include groundwater sampling in the riparian zone and in the near-shore river environment to help delineate biota exposure conditions. In addition, the scope of the pilot study does not include groundwater remedial decision making.</td></tr>
<tr><td>b.</td><td>Evaluate groundwater contamination/ mobility/recharge pathways</td></tr>
<tr><td>c.</td><td>Evaluate deep zone COCs and mobility/pathways</td></tr>
<tr><td>d.</td><td>Assess underground waste/plumes from B and C Reactor fuel storage basin leakage</td></tr>
<tr><td>e.</td><td>Characterize elevated water mounds in vadose zone</td></tr>
<tr><td>f.</td><td>Distribution coefficients used may not represent observed behavior in the soils (e.g., hexavalent chromium)</td></tr>
<tr><td>17.</td><td colspan="2">DOE should maintain the ability to re-address deep contamination if new treatment technologies are developed to address deep zone and groundwater impacts</td><td>N</td><td>This is beyond the scope of this pilot study.</td></tr>
<tr><td>18.</td><td colspan="2">Evaluate pathways for contamination to biota</td><td>Y</td><td>Biotic pathways have been evaluated in the white paper as defined by EPA ecological risk assessment guidance. Other pathways, if identified, will be evaluated.</td></tr>
<tr><td>19.</td><td colspan="2">Address potential exposure pathways to ecological receptors (e.g., birds or through unsealed structures), and include main facilities and B Reactor stack)</td><td>N</td><td>Reactor buildings are not included in the CERCLA RODs for the 100-B/C Area and therefore are not within the scope of the pilot study.</td></tr>
<tr><td>20.</td><td colspan="2">Address plant, animal, or insect intrusion into waste sites and facilities (e.g., badgers, ants, gnats, flies, bird nesting materials, snakes, mice, other rodents, and burrowing owls, sagebrush and Russian thistle)</td><td rowspan="2">Y</td><td>Facilities were not included in the scope of the pilot study. Resident animal populations will be considered for incorporation in a sampling program.</td></tr>
<tr><td>21.</td><td colspan="2">State that the major impact of groundwater is at the shoreline</td><td>Shoreline pathways were identified in the white paper and are a major focus of this pilot study.</td></tr>
</table>

Table 1-4. Interview Issues Matrix. (11 Pages)

#	Interview Issues	Accept?	Comment Resolution
River			
22.	Changes in river quality and sediment loading from upstream over time	N	This is beyond the scope this pilot study. However, this assessment will identify links to external systems (e.g., Columbia River) and will attempt to identify critical imports and exports from external systems.
23.	Evaluate river pipelines as a potential source and pathway to aquatic receptors; europium concern	N	Pipelines have been sampled. An engineering evaluation of the final disposition of the river pipelines is to be made by 2005 in accordance with a DOE commitment to EPA and Ecology in the 2002 Tri-Party Agreement modifications.
24.	Balance aquatic protection for pipeline removal versus no action	N	This pilot study will only address the near-shore environment of the Columbia River. Balancing impacts of an action versus no-action is part of the CERCLA decision process toward the 2005 Tri-Party Agreement milestone.
25.	Evaluate salmonid and other anadromous receptor risks		
	a. Beyond site boundary b. COC accumulation in downstream sediments c. Incremental risk within Hanford Reach	N	This pilot study only addresses near-shore resources of the Columbia River. However, this assessment will identify links to external systems (e.g., Columbia River) and will attempt to identify critical imports and exports from external systems.
26.	Evaluate entire river in risk assessment (cumulative for all reactor operations areas, not just for 100-B/C Area)	N	Near-shore environment will be evaluated under the scope of this pilot study. Effects on the entire Hanford Reach river system will be evaluated in a future study. This assessment will identify links to external systems (e.g., Columbia River) and will attempt to identify critical imports and exports from external systems.
27.	River contamination conditions		
	a. Evaluate conditions downstream of releases on both shorelines	N	Near-shore environment will be evaluated under the scope of this pilot study. Effects on the entire Hanford Reach river system may be evaluated in a future study. The boundary of the pilot study will be limited to the area of direct impact from 100-B/C Area operations.
28.	River stage change/contaminant mobility/pathways	Y	Evaluation will consider the range of annual river stages, etc.

Table 1-4. Interview Issues Matrix. (11 Pages)

#	Interview Issues	Accept?	Comment Resolution
29.	Evaluate surface water run-off and stream pathways to river (past and present)	Y	Surface water has been evaluated. There is no surface water entering the Columbia at the 100-B/C shoreline. A 15-mm (0.6-in.) precipitation event on June 10, 2002, did not cause run-off.
30.	Characterize river sediments for fuel COCs; develop comprehensive summary		River sediment will be characterized for all COCs pertinent to reactor operations in the near-shore areas.
31.	The river needs to be characterized for contaminants	N	River sediment will be characterized for all COCs pertinent to reactor operations, but only in the near-shore areas.
Models			
32.	Current groundwater/vadose zone models do not adequately assess COC movement	Y	Understood; the RESRAD model will need to be complemented with a groundwater model provided by the Groundwater/Vadose Zone Integration Project.
33.	The RESRAD model is not sophisticated and is inadequate for closure of radiologically contaminated sites; consult EPA guidance	N	The waste site closeout verification process uses this methodology with acceptance by the regulators.
Tribal Issues			
34.	Past treatment of Native Americans and trust issues	Y	DOE recognizes the past treatment and Native American trusts as tribal issues. DOE is striving to involve the tribes in this pilot study assessment process.
35.	Yakama Nation wants involvement with this study and its development through tribal council involvement		Appropriate communication will be maintained in accordance with Section 10.10 of the Tri-Party Agreement Action Plan, including staff-to-staff communication. Communication with Yakama participants on the Natural Resources Trustee Council will also be maintained.
36.	Confederated Tribes of the Umatilla Indian Reservation wants more involvement in revegetation and restoration process	N/A	Participation is welcomed. However, these activities are not within the scope of the pilot study.
37.	Threatened culture		DOE recognizes the past treatment and Native American trusts as tribal issues. DOE is striving to involve the tribes in this pilot study assessment process.

Table 1-4. Interview Issues Matrix. (11 Pages)

#	Interview Issues	Accept?	Comment Resolution
Project Technical Issues			
38.	Consider using background values from offsite locations (Columbia Wildlife Refuge) for background values; give rationale for onsite background values	Y	Where applicable, offsite reference locations may be used. Otherwise, background values have been established for the Hanford Site in the *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 2001b) and the *Hanford Site Background: Part 2, Soil Background for Radioactive Analytes* (DOE-RL 1996).
39.	Seal waste sites and facilities to prevent animal/plant intrusion that results in contaminating the intruders and contamination spread	N/A	The suggested response action is not within the scope of this pilot study. These actions are the responsibility of the surveillance and maintenance and interim safe storage programs.
40.	A conceptual site-wide cause/effect model was presented to the Environmental Restoration Contractor (the diagram represents thoughts on conceptual model needs)	Y	This will be considered.
41.	Roads need to be closed to reduce impacts to ecology and discourage illegal artifact removal	N/A	This response action is not within the scope of this pilot study.
42.	Protection of archaeological resources	N/A	This is not a human health or ecological protection issue and is beyond the scope of this pilot study. However, a site-specific cultural resource review will be performed for the Columbia River shoreline before sampling is initiated.
43.	Review aerial and tractor survey radionuclide results for contamination between waste sites	Y	Aerial radiological surveys will be evaluated for their usefulness in locating undiscovered contamination.
COCs			
44.	WAC 173-340-7490 ecological procedures may not include all contaminants	Y	This will be evaluated and accounted for.
45.	Investigate pesticides, organic/petroleum COCs from support facilities	Y	These contaminants will be evaluated as part of this pilot study.
46.	COC comparison and evaluation		
	a. Perform a comprehensive COC evaluation for onsite and offsite sources (include airborne sources)	N	A comprehensive COC evaluation will be conducted for only the 100-B/C Area. Also, radiological surveys will be conducted within the project boundary to identify any area that exceeds 15 mrem/yr above background. This will account for aerial deposition and hot spots.

Table 1-4. Interview Issues Matrix. (11 Pages)

#		Interview Issues	Accept?	Comment Resolution
	b.	Identify pathways by comparing COCs detected from biota surveys in the 100-B/C Area with the COCs from reactor operations to determine if COCs with biological concern have been omitted	N	Exposure pathways will be evaluated in accordance with EPA guidance.
47.	Determine full range of COCs			
	a.	Lead	Y	Pertinent contaminants are being evaluated as part of this pilot study.
	b.	Hexavalent chromium		
	c.	Mercury		
	d.	Thorium/thorium oxide		
	e.	Uranium-232, uranium-233		
	f.	Cadmium		
	g.	Zinc		
	h.	Barium		
	i.	Arsenic		
	j.	PCBs		
	k.	Persistent chlorinated materials formerly used as pesticides		
	l.	Herbicides		
	m.	Rodenticides		
	n.	Fungicides		
	o.	Full suite of reactor isotopes from fuel and tritium target activities		
Receptors/Abundance				
48.	Evaluate receptors and their abundance			
	a.	Microbiological receptors	Y	These will be addressed in this pilot study.
	b.	Reptiles		
	c.	Amphibians		
	d.	Badgers		
	e.	Gophers		
	f.	Harvester ants		
	g.	Salmonid/other anadromous species and spawning beds (HAB also wants to consider juveniles, returning adults, and young)		

Table 1-4. Interview Issues Matrix. (11 Pages)

#	Interview Issues		Accept?	Comment Resolution
	h.	Eels		
	i.	Sturgeon		
	j.	Bass and other fish		
	k.	Ducks and other river fowl		
	l.	Deer, coyotes, otters, beavers, and other transients		
49.	Establish feeding guilds		Y	This will be addressed in the pilot study.
50.	Evaluate all federally listed threatened and endangered species		Y	This will be addressed in the pilot study.
51.	Evaluate *Migratory Bird Treaty Act* species		Y	This will be addressed in the pilot study.
52.	Characterize ecological receptors from a complete species list (includes native)		Y	This will be addressed in the pilot study.
53.	Consider previous monitoring and sampling studies (HAB wants EPA study on PCBs in river)		Y	Previous monitoring and sampling studies will be addressed as applicable to the pilot study.
Ecological Sampling				
54.	Identify temporal requirements for species sampling		Y	This will be addressed in the pilot study.
55.	Use of representative species			
	a.	Resident species for ecological sampling to demonstrate protectiveness	Y	Resident species will be selected to represent appropriate feeding guilds and species most likely to be affected.
	b.	Darkling beetles	Y	This will be addressed in the pilot study.
	c.	Harvester ants	Y	This will be addressed in the pilot study.
	d.	Pocket mice	Y	This will be addressed in the pilot study.
	e.	Plants with long roots	Y	This will be addressed in the pilot study.
56.	Standard ecological sampling for receptors in all reactor areas and consistent receptors		Y	To the extent practicable, a standard sampling plan will be adapted to all reactor sites.

Table 1-4. Interview Issues Matrix. (11 Pages)

#	Interview Issues	Accept?	Comment Resolution
57.	Sampling before and after remediation	N	The sites that must still be remediated include the solid waste burial grounds, and the smaller liquid waste sites near the reactor buildings. Of these sites, only the solid waste burial grounds are large enough to support a sampling effort of this type. However, because they are maintained free of vegetation and provide very limited habitat to support biota sampling, they do not constitute a suitable sampling area.

ARAR = applicable or relevant and appropriate requirement
AWQC = ambient water quality criteria
FS = feasibility study
MTCA = *Model Toxics Control Act* (WAC 173-340)
N/A = not applicable to the pilot study
PCB = polychlorinated biphenyl
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
RL = U.S. Department of Energy, Richland Operations Office
UCL = upper confidence limit
WAC = *Washington Administrative Code*

1.5.2 Global Issues

Global issues are issues of magnitude that exceed the scope of the project or are defined as complex technical issues. The global issues identified for the 100-B/C pilot study are presented below:

- **Global Issue #1:** The "avid recreationalist" and the "Native American" human health exposure scenarios were planned for inclusion in this DQO process but have not been developed to date.

  Resolution: The absence of these exposure scenarios will not affect the pilot study at this stage; however, the final assessment of human health cannot be made without established scenarios for these potentially exposed members of the public. The "avid recreationalist" scenario is generally considered to be definable within the technical community. However, the "Native American" scenarios will require the Tribal Nations to provide input on the essential elements that define these scenarios.

- **Global Issue #2:** The scope of the pilot study is limited to the remediated waste sites in the upland areas. The scope does not include cleanup of the upland areas between and outside of the remediated waste sites.

  Resolution: The project decision makers (RL, EPA, and Ecology) established this scope definition for the pilot study with the understanding that the areas between and outside of remediated waste sites would be handled as land transfer issues outside the 100-B/C Area pilot study.

- **Global Issue #3:** The scope of the pilot study includes groundwater sampling at its emergence into the river to assess risk from current conditions.

  Resolution: The project decision makers established the scope definition for the pilot study with the understanding that groundwater remediation issues will be resolved in coordination with the Groundwater Protection Project (hereinafter referred to as the Groundwater Project). The data collected by the pilot study will be made available to the Groundwater Project. Future exposures from groundwater assessed by the pilot study will be addressed by the Groundwater Project.

- **Global Issue #4:** The Columbia River aquatic environment is limited to the 100-B/C Area near-shore as the groundwater impacts on river water quality are localized along the shoreline.

  Resolution: The project decision makers established this scope definition for the pilot study, given that the riverine system is too broad in scope for the pilot study and may be assessed in a subsequent study.

- **Global Issue #5:** The upland terrestrial ecology at the 100-B/C Area may need time to recover from remediation activities before biota populations can re-establish sufficiently to yield meaningful ecological data.

  Resolution: The project decision makers recognized this temporal aspect of the ecosystem to enable meaningful data collection and decision making. This is addressed by recognizing the need for long-term monitoring.

- **Global Issue #6:** Deletion from National Priorities List (NPL) is only partial, and institutional controls will be applied below 4.6 m (15 ft) after land transfer.

  Resolution: The decision makers have determined that the NPL deletion is only partial and requires institutional controls after land transfer below depths of 4.6 m (15 ft) below ground surface, because remediation was generally not performed below that depth.

- **Global Issue #7:** If protectiveness cannot be demonstrated for the 100-B/C Area, the project remains in the remedial action phase until protectiveness is established.

  Resolution: The decision makers have determined that this issue can only be resolved after completion of the data assessment and risk evaluation. Contingencies must be understood from a regulatory standpoint.

1.6 PROJECT ASSUMPTIONS

The project assumptions for the 100-B/C pilot study DQO include the following:

- The DQO process will follow the process outlined in BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2, "Data Quality Objectives."
- Remediated waste sites in the upland area within the scope of this pilot study are as follows:
  - 116-B-1 Liquid Waste Disposal Trench
  - 116-B-11 Retention Basin
  - 116-B-13 Sludge Trench
  - 116-B-14 Sludge Trench
  - 116-C-1 Liquid Waste Disposal Trench
  - 116-C-5 Retention Basins
  - 116-B-7 Outfall Structure
  - 132-B-6 Outfall Structure
  - 132-C-2 Outfall Structure.
- Existing characterization data from the limited field investigations (LFIs), data collected during site remediation, and site closeout will be used to support the DQO process.
- The DQO summary report will be used to prepare a SAP for further soil, water, and biological sampling.
- Upland exposure scenarios will be based on the approach presented in *Washington Administrative Code* (WAC) 173-340-7490 (et seq.). For purposes of this DQO process, the terrestrial ecological screening criteria presented in WAC 173-340-900, Table 749-3 are considered suitable for the waste sites being considered.
- Ecological exposure scenarios consider the aquatic, riparian, and upland areas.
- The list of contaminants of potential concern (COPCs) includes contaminants associated with reactor operations that were compiled during the LFIs (DOE-RL 1994a, 1994b, 1994c).

- Some contaminants are identified as COPCs for ecological receptors in accordance with WAC 173-340-900, Table 749-3, but are not identified as contaminants associated with the 100-B/C Area. All contaminants were evaluated for ecological and human health risk.

- For radiological constituents, screening levels will be calculated based on the Biota Dose Assessment Committee's *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002).

- The rural-residential human health exposure scenario is included in this DQO summary report. The Native American subsistence and avid recreationalist exposure scenarios will be evaluated and developed in the future.

- The 95% upper confidence limit (UCL) or maximum detected contaminant concentration value will be used for comparison to screening levels.

- Biota sampling timeframes are limited and necessary biota sampling must be conducted during appropriate seasons (spring/summer/fall) to obtain representative samples.

1.7 DEFINITIONS

Waste site buffer zone – Perimeter area (up to 25 m [82 ft] wide) surrounding remediated waste site shallow zone excavation limits. This upland area has the greatest potential for deep-rooted plants and burrowing animals to contact low levels of residual contamination (Figure 1-1).

Upland zone – Area containing vegetation that is adapted to dryland conditions where plants are not influenced by the water table.

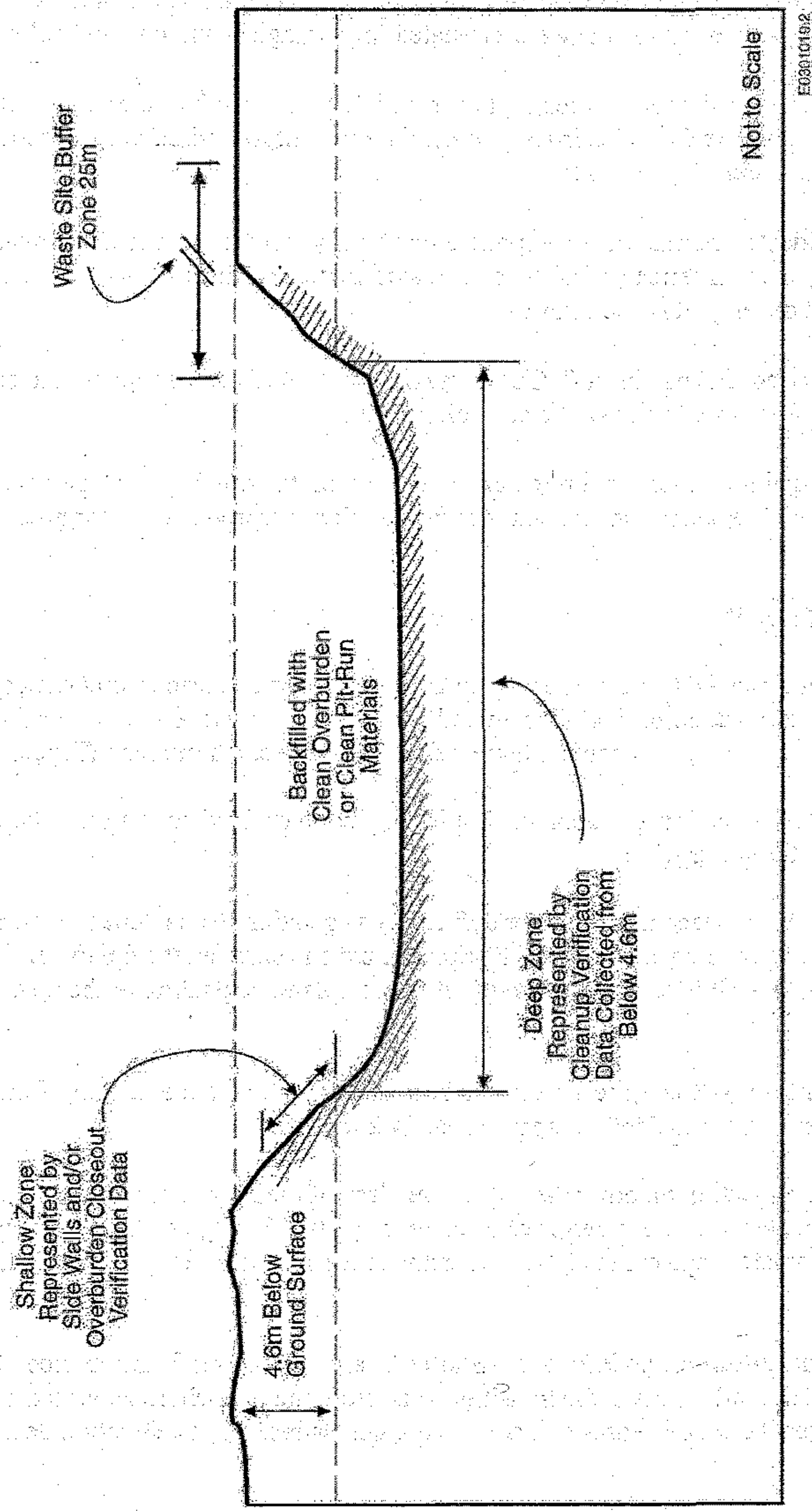
Riparian zone – Area adjacent to the river defined by vegetation that is dependent on soil moisture contributed by the water table. The riparian zone is between the upland and the near-shore river zones. It extends from the onset of the upland vegetation to the near-shore "green line."

Near-shore river zone – Shoreline area that is permanently inundated extending from the "green line" into the river to a water depth of approximately 2 m (6 ft).

"Green line" – Delineation marking the upper boundary of the near-shore environment that is permanently inundated where the periphyton remains green. This "green line" corresponds to the minimum flow rate (approximately 45,000 cubic feet per second [cfs]) of the Columbia River.

Frequent river inundation (varial) zone – Shoreline area extending from the green line to the ordinary high-water mark. This is the transition zone from the near-shore zone to the riparian zone. Riparian vegetation decreases and aquatic organisms increase as elevation decreases (see DQO Step 4).

Figure 1-1. Cross-Section and Top View of Waste Site Buffer Zone.



Reference site – A paired sampling area selected to match the physical environment, the habitat, and the species present at a site of interest being investigated for contaminant effects. The reference site represents an area not affected by the COCs.

Monument – The Hanford Reach National Monument, as defined in Presidential Proclamation 7319, dated June 9, 2000. The monument extends 0.4 km (0.25 mi) inland along the 100 Areas of the Hanford Site.

Sentinel species – Organisms that accumulate contaminants and provide a time-integrated measure of the contaminant bioavailability.

Indicator species – Those organisms, or defined assemblages of organisms, that are sensitive to elevated levels of contaminants in their environment and the "endpoint" (manifestations of injury that may be critical to individual- or population-level survival) is measurable at some stage in the organism's life history, (i.e., healthy organs and tissues, growth rates, survival rates, and recruitment rates).

1.8 SITE BACKGROUND INFORMATION

Because of the amount of reference material available that describes the 100-B/C Area, this section will refer only to the pertinent descriptive documents rather than attempting to reiterate the process history, remediation, and environmental conditions.

The 100-B Area technical baseline report (Carpenter 1994) provides descriptions of the facilities and waste sites in the 100-B/C Area and discussions of their functions. A general description of the Hanford Site environment (including site-specific information such as climate and meteorology; geology; hydrology; ecology; cultural, archaeological, and historical resources; socioeconomics; occupational safety; and noise) is provided in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Neitzel 2002). A description of the ecological setting of the 100-B/C Area (including the upland areas, the riparian zone, and the near-shore river environment) is provided in Doctor et al. (2002).

1.9 EXISTING REFERENCES

Table 1-5 presents a list of pertinent references that were reviewed as part of this DQO scoping process, as well as a summary of the relevant information contained within each reference. These references are the primary source for the background information presented in Section 1.6.

Table 1-5. Existing References. (3 Pages)

Reference	Summary
An Aerial Radiological Survey of the Hanford Site and Surrounding Area (Reiman and Dahlstrom 1990)	An aerial radiological survey of the Hanford Site conducted in 1988 that showed gamma exposure rates.
Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (DOE 1999)	This plan established the foundation for land-use planning on the Hanford Site. Implementation will begin a more detailed planning process for land-use and facility-use decisions. Management of the Hanford Site areas will eventually move toward the plan's land-use goals.
100-B Area Technical Baseline Report (Carpenter 1994)	This document contains characterization data and operational histories of the B and C Reactors and each of their associated liquid and solid waste sites.
Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE-RL 2002)	This RDR/RAWP includes the 100-B/C Area.
Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington (EPA et al. 1995)	Interim ROD that includes the 100-B/C Area.
100 Area Burial Grounds Remedial Action Sampling and Analysis Plan (DOE-RL 2001a)	SAP that includes the 100-B/C Area.
"Natural Resource Damage Assessments" (43 CFR 11)	A planned and phased approach to the assessment of natural resource damages.
Hanford Site Biological Resources Management Plan (DOE-RL 2001c)	Identifies resource management strategies and mitigation requirements, as well as habitat types and species associations, in all areas of the Hanford Site.
Hanford Site Biotic Database (Duratek 2002)	Includes Hanford Site-wide soil and vegetation sample data.
Ecological and cultural resource reviews (generally conducted to support remedial action and other field work that may impact ecological or cultural resources) (BHI 1996a, 1996b, 1997, 1998b, 2000a, 2000b, 2000c)	These letter reports include the habitat types present and the potential receptors associated with the vegetation present. Cultural reviews identify culturally sensitive and historical areas.
Habitat Types on the Hanford Site: Wildlife and Plant Species of Concern (Downs et al. 1993)	Describes the various habitat types on the Hanford Site and the associated species. Also lists plant and animal species of concern.
Vascular Plants of the Hanford Site (Sackschewsky and Downs 2001)	This report provides an updated listing of the vascular plants present on and near the Hanford Site. It includes a listing of endangered or threatened plants and plants that are otherwise of concern. It also provides an overview of how plants on the Hanford Site can be used by people.

Table 1-5. Existing References. (3 Pages)

Reference	Summary
Habitat Requirements and Burrowing Depths of Rodents in Relation to Shallow Waste Burial Sites (Gano and States 1984)	Literature review of habitat requirements and burrowing depths of various rodents.
Rooting Depth and Distributions of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site (Klepper et al. 1985)	Documents rooting depths of various deep-rooted plants on the Hanford Site.
100 Areas CERCLA Ecological Investigations (Landeen et al. 1993)	This document provides descriptions of flora and fauna associated with the 100 Areas, emphasizing potential pathways for contaminants and species that have been given special status and an evaluation of existing concentrations of heavy metals and radionuclides in biota.
Biological Assessment for Rare and Endangered Plant Species Related to CERCLA Characterization Activities (Sackschewsky 1992)	This document lists rare and special status plants found on the Hanford Site. No Federally listed threatened or endangered plant species are present on the Hanford Site.
Fiscal Year 1991 100 Areas CERCLA Ecological Investigations (Sackschewsky and Landeen 1992)	This report provides the results of field investigations in the 100 Areas, including bird surveys, mammal and insect surveys, vegetation surveys, and vegetation sampling. Site-specific data from 100-B/C Area are included.
A Synthesis of Ecological Data from the 100 Areas of the Hanford Site (Weiss and Mitchell 1992)	A review of nearly 50 years of available data with emphasis on documents of a summary nature and broad-based ecological and radiological reports. Emphasis was placed on highlighting the breadth of work conducted and providing the sources of the information.
Survey of Radiological Contaminants in the Near-Shore Environment at the Hanford Site 100-N Reactor Area (Van Verst et al. 1998)	Contaminants were sampled and screening-level risk assessments were conducted for human and ecological receptors.
Hanford Site National Environmental Policy Act (NEPA) Characterization (Neitzel 2002)	This document is updated annually and provides a detailed description of the Hanford environment for use in preparing NEPA documents. Includes descriptions of climate, geology, hydrology, ecology, archaeology, and socioeconomics.
Hanford Environmental Information System database	Contains well information and sampling data.
A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE 2002)	Provides a graded approach for evaluating radiation doses to aquatic and terrestrial biota used for demonstrating compliance with DOE dose limits, and with findings of the International Atomic Energy Agency and National Council on Radiation Protection and Measurements regarding doses, below which deleterious effects on populations of aquatic and terrestrial organisms have not been observed; provides screening concentrations for the screening-level risk assessment.

Table 1-5. Existing References. (3 Pages)

Reference	Summary
Model Toxics Control Act (WAC 173-340)	Provides soil concentrations that are considered to be protective of humans and terrestrial ecological receptors to be used in the screening-level risk assessment for nonradiological constituents.
Ecological Assessment Guidance for Superfund – Process for Designing and Conducting Ecological Risk Assessments (EPA 1997)	EPA's guidance for a tiered approach to ecological risk evaluation, including a screening-level risk assessment and a more intensive, baseline risk assessment process for sites that exceed screening-level concentrations; directed at CERCLA sites.
Guidelines for Ecological Risk Assessment (EPA 1998)	EPA's general guidance for conduction ecological risk assessments.
ECO Update, The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (EPA 2001)	Provides directed guidance on the use of the screening-level risk assessment to focus the baseline risk assessment and to reduce the list of COCs that need to be evaluated further.
Biodiversity Inventory and Analysis of the Hanford Site, Final Report 1994-1999 (TNC 1999)	Identifies potential receptor species and habitat.
WAC 173-340-900, Table 749-3	Ecological indicator soil concentrations (mg/kg) for protection of terrestrial plants and animals.
Limited Field Investigation Report for the 100-BC-1 Operable Unit (DOE-RL 1994a)	Summarizes data collection and analysis activities conducted in the 100-BC-1 source OU.
Limited Field Investigation Report for the 100-BC-2 Operable Unit (DOE-RL 1994b)	Summarizes data collection and analysis activities conducted in the 100-BC-2 source OU.
Limited Field Investigation Report for the 100-BC-5 Operable Unit (DOE-RL 1994c)	Summarizes data collection and analysis activities conducted in the 100-BC-5 source OU.
CVPs for individual remediated waste sites	These reports document the results of the soil sampling that performed after remediation was completed to demonstrate compliance with the remedial action objectives defined in the ROD. As of December 31, 2002, a total of 21 waste sites in the 100-B/C Area have been remediated and CVPs have been issued.

CVP = cleanup verification package
NEPA = *National Environmental Policy Act of 1969*

1.10 CONTAMINANTS OF CONCERN

The 100-B/C technical baseline report (Carpenter 1994) describes the process history for the 100-B/C Area and the radionuclides and chemicals that were used or produced during reactor operations. Soils and water associated with high-priority waste sites were sampled during the remedial investigation phase of the CERCLA process in 1993. This sampling and analysis effort, referred to as the 100 Area LFI, was conducted for more than 200 analytes, including radionuclides, metals, general chemistry constituents, pesticides, as well as volatile organic analytes (VOAs) and semi-volatile organic analytes (SVOAs) (DOE-RL 1994a, 1994b, 1994c). The list is comprehensive and includes contaminants not known to be present in the 100-B/C Area but that were included for completeness.

Table 1-6 lists the contaminants from the 100-B/C LFIs as the starting point for development of COPCs for this DQO process.

Table 1-6. Sources of Contamination, COPCs, and Affected Media for the 100-B/C Area. (2 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	Affected Media
Liquid and solid waste discharges from operation of the 105-B and 105-C Reactor buildings.	Various aqueous and solid waste streams containing, mixed fission products, activation products, inorganic chemicals, metals, and semi-volatile and volatile organic chemicals.	Shallow and deep zone soils associated with the waste sites, potentially the groundwater beneath the waste sites, and river water.

Radioactive COPCs			
Americium-241	Europium-152	Plutonium-241	Thorium-228
Barium-140	Europium-154.	Potassium-40	Thorium-232
Beryllium-7	Europium-155	Radium-226	Thorium-234
Carbon-14	Iodine-129	Radium-228	Tin-113
Cerium-141	Iodine-131	Ruthenium-103	Tritium
Cerium-144	Iron-59	Ruthenium-106	Uranium-232
Cesium-134	Manganese-54	Silver-108m	Uranium-233/234
Cesium-137	Nickel-63	Sodium-22	Uranium-235
Chromium-51	Niobium-94	Strontium-90	Uranium-238
Cobalt-58	Plutonium-238	Technetium-99	Zinc-65
Cobalt-60	Plutonium-239/240		Zirconium-95

Inorganic COPCs			
Aluminum	Chromium	Magnesium	Silver
Antimony	Cobalt	Manganese	Sodium
Arsenic	Copper	Mercury	Sulfate
Barium	Cyanide	Molybdenum	Technetium
Beryllium	Fluorine	Nickel	Thallium
Boron	Hexavalent chromium	Nitrate	Tin
Bromine	Iodine	Nitrite	Uranium
Cadmium	Iron	Phosphate	Vanadium
Calcium	Lead	Potassium	Zinc
Chloride	Lithium	Selenium	

Table 1-6. Sources of Contamination, COPCs, and Affected Media for the 100-B/C Area. (2 Pages)

Organic Chemical COPCs			
Acenaphthene	4-chloroaniline	cis-1,3-dichloropropene	Naphthalene
Acenaphthylene	Chlorobenzene	Trans-1,3-dichloropropene	2-nitroaniline
Acetone	3,3'-dichlorobenzidine	Diesel range organics	3-nitroaniline
Anthracene	Chloroethane	Diethylphthalate	4-nitroaniline
Aroclor-1016	Bis(2-chloroethoxy) methane	2,4-dimethylphenol	2-nitrophenol
Aroclor-1221	Bis(2-chloroethyl) ether	Dimethylphthalate	4-nitrophenol
Aroclor-1232	Chloroform	Di-n-butylphthalate	N-nitroso-di-n-dipropylamine
Aroclor-1242	Chloromethane	2,4-dinitrophenol	N-nitrosodiphenylamine
Aroclor-1248	Bis(2-chloro-1 methylethyl) ether	2,4-dinitrotoluene	Nitrobenzene
Aroclor-1254	4-chloro-3-methylphenol	2,6-dinitrotoluene	Pentachloroaniline
Aroclor-1260	2-chloronaphthalene	4,6-dinitro-2-methylphenol	Pentachlorobenzene
Benzene	2-chlorophenol	Di-n-octylphthalate	Pentachlorophenol
Benzo(a)anthracene	3-chlorophenol	Dioxins	Phenanthrene
Benzo(a)pyrene	4-chlorophenylphenyl ether	Ethylbenzene	Phenol
Benzo(b)fluoranthene	Chrysene	Bis(2-ethylhexyl) phthalate	Pyrene
Benzo(ghi)perylene	Dibenz[a,h]anthracene	Fluoranthene	Styrene
Benzo(k)fluoranthene	Dibenzofuran	Fluorene	2,3,4,6-tetrachloroaniline
Benzoic acid	Dibromochloromethane	Furan	1,2,4,5-tetrachlorobenzene
Benzyl alcohol	2,4-dichloroaniline	Gasoline range organics	1,1,2,2-tetrachloroethane
Biphenyl	3,4-dichloroaniline	Hexachlorobenzene	Tetrachloroethene
Bromodichloromethane	1,2-dichlorobenzene	Hexachlorobutadiene	2,3,4,6-tetrachlorophenol
Bromoform	1,3-dichlorobenzene	Hexachlorocyclopentadiene	2,4,5-trichloroaniline
Bromomethane	1,4-dichlorobenzene	Hexachloroethane	1,2,3-trichlorobenzene
4-bromophenylphenyl ether	1,1-dichloroethane	Hexane	1,2,4-trichlorobenzene
2-butanone (MEK)	1,1-dichloroethene	2-hexanone	1,1,1-trichloroethane
Butylbenzylphthalate	1,2-dichloroethane	Indeno(1,2,3-cd)pyrene	1,1,2-trichloroethane
Carbazole	1,2-dichloroethene(total)	Isophorone	Toluene
Carbon disulfide	2,4-dichlorophenol	Methylene chloride	Trichloroethene (TCE)
Carbon tetrachloride	3,4-dichlorophenol	2-methylnaphthalene	2,4,5-trichlorophenol
Chlorinated dibenzofurans (total)	1,2-dichloropropane	4-methyl-2-pentanone	2,4,6-trichlorophenol
Chloroacetamide		2-methylphenol (cresol, o-)	Vinyl acetate
3-chloroaniline		4-methylphenol (cresol, p-)	Vinyl chloride
			Xylenes (total)
Pesticide/Herbicide COPCs			
Aldrin	Dichlorodiphenyldichlorethane (DDD)	Dieldrin	Endrin ketone
Alpha-BHC	Dichlorodiphenyldichloroethylene (DDE)	Endosulfan I	Gamma-BHC (Lindane)
Alpha-chlordane	Dichlorodiphenyltrichloroethane (DDT)	Endosulfan II	Gamma-chlordane
Beta-1,2,3,4,5,6 hexachlorocyclohexane		Endosulfan sulfate	Heptachlor/heptachlor epoxide
Delta-BHC		Endrin	Methoxychlor
		Endrin aldehyde	Toxaphene

The COPCs listed in Table 1-6 were evaluated against a set of exclusion criteria to determine if the constituents should be retained as COCs or excluded from further consideration. The specific COPC exclusion rationales are summarized as follows:

- Short-lived radionuclides with half-lives less than 3 years
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Contaminants not detected, or detected at low rates, in LFI sampling
- Contaminants for which WAC 173-340 does not provide action levels
- Naturally occurring elements present in background concentrations
- Constituents that would be neutralized and/or decomposed in the soil environment
- Chemicals in the gaseous state that cannot accumulate in soil media
- Chemicals that are not persistent in the soil environment due to chemical instability volatilization, biological degradation, or other natural mitigating features.

Tables 1-7 and 1-8 list the radionuclide and nonradionuclide COPCs, respectively, excluded from further consideration with supporting exclusion logic. The COPCs listed in Tables 1-7 and 1-8 that have no exclusion logic are retained as final COCs. The final COC list is provided in Table 1-9 with retention logic.

Table 1-7. COC Screening for Radionuclides. (3 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (pCi/g)	Site Back-ground Value (pCi/g)	BCG (pCi/g)	Human Health Action Level (pCi/g)	Exclusion Rationale
Americium-241	55	17	34	--	4,000	31.1	
Barium-140	17	1	1.3	--	--	--	Short half-life (12.75 days).
Beryllium-7	17	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (53 days).
Carbon-14	55	3	0.41	--	--	2.0	Low detection rate.
Cerium-141	17	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (32.5 days).
Cerium-144	27	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (285 days).
Cesium-134	55	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (2.1 years).
Cesium-137	55	28	800	1.1	20	6.2	
Chromium-51	28	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (51 days).
Cobalt-58	27	2	--	--	--	--	Short half-life (28 days). Two detections are indication of false-positive results.
Cobalt-60	55	20	310	0.008	700	1.4	
Europium-152	40	19	1,400	--	1,400	3.3	
Europium-154	37	15	410	0.33	1,000	3.0	
Europium-155	29	7	41	0.054	20,000	125	
Iodine-129	10	0	--	--	--	--	Nondetection in the LFI sampling.
Iodine-131	14	0	1,000	--	--	--	Nondetection in the LFI sampling and short half-life (8 days).
Iron-59	31	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (45 days).
Manganese-54	27	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (312 days).
Nickel-63	11	10	3,200	--	--	4,026	

Table 1-7. COC Screening for Radionuclides. (3 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (pCi/g)	Site Back-ground Value (pCi/g)	BCG (pCi/g)	Human Health Action Level (pCi/g)	Exclusion Rationale
Niobium-94	10	0	--	--	--	--	Nondetection in the LFI sampling.
Plutonium-238	42	10	0.0878	0.004	5,400	37.4	
Plutonium-239/240	55	23	0.0183	0.025	6,000	33.9	
Plutonium-241	11	0	--	--	150,000	--	Nondetection in the LFI sampling; a calculated value from plutonium-239/240.
Potassium-40	55	50	23.6	16.6	2,200	--	Naturally occurring isotope not created as a result of Hanford Site operations.
Radium-226	55	39	1.51	--	3	--	Not produced by Hanford Site operations.
Radium-228	10	7	4	--	2	--	Not produced by Hanford Site operations.
Ruthenium-103	27	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (39 days).
Ruthenium-106	31	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (1 year).
Silver-108m	0	0	--	--	--	2.38	
Sodium-22	2	2	5.46	--	--	--	Short half-life (2.6 years).
Strontium-90	55	37	0.988	0.18	20	4.5	
Technetium-99	15	0	--	--	4,000	15[a]	Not detected in soil samples. Retained as 100 Area RDR COC and because of detection in groundwater.
Thorium-228	55	41	1.35	--	2,200	--	Short half-life (1.9 years) daughter of thorium-232.
Thorium-232	37	21	2.135	1.3	2,000	1.3	
Thorium-234	12	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (24 days). Daughter of uranium-238.
Tin-113	10	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (115 days).
Tritium	11	0	--	--	--	400	Not detected in LFI soil samples. It is retained as 100 Area RDR COC and because of detection in groundwater.

Table 1-7. COC Screening for Radionuclides. (3 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (pCi/g)	Site Back-ground Value (pCi/g)	BCG (pCi/g)	Human Health Action Level (pCi/g)	Exclusion Rationale
Uranium-232	--	--	--	--	--	--	Trace quantities were produced during reactor operations, but the relative quantities are so small that it is essentially not detectable.
Uranium-233/234	39	35	1.4	1.1	5,000	1.1	
Uranium-235	55	16	.081	0.11	3,000	1.0	
Uranium-238	55	54	1.3	1.1	2,000	1.1	
Zinc-65	45	1	19	--	--	--	Low detection rate and short half-life (244 days).
Zirconium-95	17	0	--	--	--	--	Nondetection in the LFI sampling and short half-life (64 days).

[a] The RAG is below the required detection limit. The value shown is the required detection limit.
-- = not available
BCG = biota concentration guide

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Inorganic COPCs												
Aluminum	62	62	14,200	11,800	50	--	--	--	11,800	--	Hanford reactor operations did not engage in processes that used or generated soluble forms of aluminum. It is only present in background concentrations and is not in soluble salt form.	
Antimony	62	1	4.6	--	5	--	--	6.0	5	6.0	Low rate of detection in the LFI data.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Arsenic[c]	62	48	5.3	20[d]	--	--	7	.05	20[d]	20[d]	Maximum detection below site background.	
Barium	62	62	484	132	500	--	102	132	132	132		
Beryllium	62	34	0.84	1.51	10	--	--	32	10	32	Maximum detection below site background, screening, and regulatory limits.	
Cadmium	62	6	1.8	0.81[e]	4	20	14	0.81[e]	4	0.81[e]		
Calcium	62	61	46,600	17,200	--	--	--	--	--	--	Calcium is an essential nutrient that is non-toxic under typical environmental exposure scenarios and only present in background concentrations.	
Chloride	4	4	27.2	--	--	--	--	1,000	--	1,000	No WAC 173-340 action levels.	Maximum detection below regulatory limits.
Chromium	62	60	0.41	18.5[f]	42	42	67	18.5[f]	42	18.5[f]		
Chromium (VI)	6	5	5.03	18.5[f]	--	--	--	2.2	--	2.2		
Cobalt	62	57	16.4	15.7	20	--	--	--	20	--	Maximum detected value < screening limit.	No WAC 173-340 action levels.
Copper	62	52	21.6	22	100	50	217	6.9	50	22	Maximum detected value below site background, screening, and regulatory limits.	
Cyanide	44	0	--	--	--	--	--	320	--	320	Not detected in LFI sampling.	
Fluoride	38	23	4.4	--	--	--	--	16	--	16	No WAC 173-340 action levels.	Maximum detected value < regulatory limit.

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Iron	62	62	44,600	32,600	--	--	--	--	--	--	Iron is an essential nutrient that is non-toxic under typical environmental exposure scenarios and only present in background concentrations.	
Lead	28	14	564	10.2	50	100	118	10.2	50	10.2		
Magnesium	62	61	44.6	7,060	--	--	--	--	--	--	Magnesium is an essential nutrient that is non-toxic under typical environmental exposure scenarios and only present in background concentrations.	
Manganese	62	62	661	512	1,100	--	1,500	512	1,100	512	Maximum detected value < screening limit.	
Mercury (inorganic)	28	14	4.3	0.33	0.3	0.1	5.5	0.33	0.33	0.33		
Mercury (organic)	58	14	4.3	--	--	--	0.4	--	0.4	--	Inorganic mercury levels will be used.	
Nickel	62	55	117	19.1	30	200	980	130	30	130		Maximum detected value < regulatory limit.
Nitrate (as nitrogen)	35	34	1.4	--	--	--	--	40	--	40	No WAC 173-340 action levels.	Maximum detected value < regulatory limit.
Nitrite	1	0	--	--	--	--	--	1,600	--	1,600	No WAC 173-340 action levels.	Not detected in LFI sampling.
Phosphate	4	0	--	--	--	--	--	--	--	--	No WAC 173-340 action levels.	No WAC 173-340 action levels.

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening[c] Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Potassium	62	59	704	2,150	--	--	--	--	--	--	Potassium is an essential nutrient that is non-toxic under typical environmental exposure scenarios and only present in background concentrations.	
Selenium	62	3	4.3	0.78[e]	1	70	0.3	400	0.78[e]	400		
Silver	62	15	3	0.73	2	--	--	400	2	400		
Sodium	62	47	779	690	--	--	--	--	--	--	Sodium is an essential nutrient that is non-toxic under typical environmental exposure scenarios and only present in background concentrations.	
Sulfate	49	42	566	--	--	--	--	25,000	--	25,000	No WAC 173-340 action levels.	Maximum detected value < regulatory limit.
Thallium	62	1	0.22	0.6	1	--	--	1.12	1	1.12	Low rate of detection and maximum detected value < background, screening, and regulatory limits.	
Uranium	0	0	--	TBD	5	--	--	3	5	3	Uranium was analyzed as a radionuclide during the LFIs. A conservative estimate of total uranium is based on the maximum activity for the uranium isotopes 234, 235, and 238, which corresponds to 3.91 mg/kg and is above that ecological screening level.	
Vanadium	62	61	76.9	85.1	2	--	--	112	85.1[f]	112	Maximum detection less than background value.	
Zinc	62	61	3.9	67.8	86	200	360	67.8	86	67.8	Maximum detected value < background, screening, and regulatory limits.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Organics												
Acenaphthene	92	0	--	--	20	--	--	97.9	20	97.9	Not detected in LFI sampling.	
Acenaphthylene	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Acetone	50	8	0.06	--	--	--	--	3.21	--	3.21	No WAC 173-340 action levels.	Maximum detection < regulatory limit.
Anthracene	46	0	--	--	--	--	--	1,140	--	1,140	Not detected in LFI sampling.	
Aroclor-1016[h]	60	0	--	--	40[h]	--	0.65[h]	0.5[h,i]	0.65[h]	0.5[h,i]	Not detected in LFI sampling.	
Aroclor-1221[h]	60	0	--	--	40[h]	--	0.65[h]	0.5[h,I]	0.65[h]	0.5[h,i]	Not detected in LFI sampling.	
Aroclor-1232[h]	60	0	--	--	40[h]	--	0.65[h]	0.5[h,i]	0.65[h]	0.5[h,i]	Not detected in LFI sampling.	
Aroclor-1242[h]	59	0	--	--	40[h]	--	0.65[h]	0.5[h,I]	0.65[h]	0.5[h,i]	Not detected in LFI sampling.	
Aroclor-1248[h]	60	0	--	--	40[h]	--	0.65[h]	0.5[h,i]	0.65[h]	0.5[h,i]	Not detected in LFI sampling.	
Aroclor-1254[h]	60	12	6.4	--	40[h]	--	0.65[h]	0.5[h,I]	0.65[h]	0.5[h,i]		
Aroclor-1260[h]	60	12	0.34	--	40[h]	--	0.65[h]	0.5[h,i]	0.65[h]	0.5[h,i]		
Benzene	50	1	0.001	--	--	--	--	4.48E-3	--	4.48E-3	Low detection rate and detected value < HH regulatory limit.	
Benzo(a) anthracene	46	2	0.16	--	--	--	--	2.8E-3	--	2.8E-3	Low detection rate and reported detects barely exceed the detection limit.	
Benzo(a)pyrene	92	0	--	--	--	--	12	2.8E-3	12	2.8E-3	Not detected in LFI sampling.	
Benzo(b)-fluoranthene	46	2	0.39	--	--	--	--	2.8E-3	--	2.8E-3	Low detection rate and reported detects barely exceed the detection limit.	
Benzo(ghi)-perylene	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Benzo(k)-fluoranthene	46	2	0.1	--	--	--	--	2.8E-3	--	2.8E-3	Low detection rate and reported detects barely exceed the detection limit.	
Benzoic acid	30	2	0.1	--	--	--	--	64,000	--	64,000	No WAC 173-340 action levels.	Reported detects much less than regulatory limit.
Benzyl alcohol	30	0	--	--	--	--	--	4,800	--	4,800	Not detected in LFI sampling.	
Bromodichloro-methane	50	0	--	--	--	--	--	0.7	--	0.7	Not detected in LFI sampling.	
Bromoform	50	0	--	--	--	--	--	5.54	--	5.54	Not detected in LFI sampling.	
Bromomethane	50	0	--	--	--	--	--	11.2	--	11.2	Not detected in LFI sampling.	
4-bromo-phenylphenyl ether	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
2-butanone (MEK)	50	2	0.005	--	--	--	--	21.8	--	21.8	Low detection rate and detected value < HH regulatory limit.	
Butylbenzyl-phthalate	46	1	0.048	--	--	--	--	892	--	892	Low detection rate and detected value < HH regulatory limit.	
Carbazole	16	0	--	--	--	--	--	0.314	--	0.314	Not detected in LFI sampling.	
Carbon disulfide	50	2	0.012	--	--	--	--	5.65	--	5.65	Low detection rate and detected value < HH regulatory limit.	
Carbon tetrachloride	50	0	--	--	--	--	--	3.1E-3	--	3.1E-3	Not detected in LFI sampling.	
4-chloroaniline	46	0	--	--	--	--	--	64	--	64	Not detected in LFI sampling.	
Chlorobenzene	50	0	--	--	--	--	--	87.4	--	87.4	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Chloroethane	50	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Bis(2 chloro-ethoxy) methane	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Bis(2 chloro-ethyl) ether	46	0	--	--	--	--	--	0.039	--	0.039	Not detected in LFI sampling.	
Chloroform	50	2	0.002	--	--	--	--	3.8E-2	--	3.8E-2	Low detection rate and detected value < HH regulatory limit.	
Chloromethane	50	0	--	--	--	--	--	3.34E-2	--	3.34E-2	Not detected in LFI sampling.	
Bis(2-chloro-1-methylethyl) ether	46	0	--	--	--	--	--	1.25	--	1.25	Not detected in LFI sampling.	
4-chloro-3-methyl phenol	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
2-chloro naphthalene	46	0	--	--	--	--	--	1,030	--	1,030	Not detected in LFI sampling.	
2-chlorophenol	46	0	--		--	--	--	0.943	--	0.943	Not detected in LFI sampling.	
4-chlorophenyl phenyl ether	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Chrysene	46	1	0.1	--	--	--	--	0.33[c]	--	0.33[c]	Low detection rate and detections barely over the detection limit.	
Dibenz[a,h] anthracene	46	0	--	--	--	--	--	0.012	--	0.012	Not detected in LFI sampling.	
Dibenzofuran	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Dibromochloro-methane	50	0	--	--	--	--	--	0.521	--	0.521	Not detected in LFI sampling.	
1,2-dichloro-benzene	46	0	--	--	--	--	--	7.03	--	7.03	Not detected in LFI sampling.	
1,3-dichloro-benzene	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
1,4-dichloro-benzene	92	0	--	--	--	--	--	3.0E-2	--	3.0E-2	Not detected in LFI sampling.	
3,3'-dichloro-benzidine	46	0	--	--	--	--	--	4.62E-2	--	4.62E-2	Not detected in LFI sampling.	
1,1-dichloro-ethane	50	0	--	--	--	--	--	4.37	--	4.37	Not detected in LFI sampling.	
1,1-dichloro-ethene	50	0	--	--	--	--	--	5.22E-4	--	5.22E-4	Not detected in LFI sampling.	
1,2-dichloro-ethane	50	0	--	--	--	--	--	2.32E-3	--	2.32E-3	Not detected in LFI sampling.	
1,2-dichloro-ethene	50	0	--	--	--	--	--	70	--	70	Not detected in LFI sampling.	
2,4-dichloro-phenol	46	0	--	--	--	--	--	48	--	48	Not detected in LFI sampling.	
1,2-dichloro-propane	50	0	--	--	--	--	--	3.3E-3	--	3.3E-3	Not detected in LFI sampling.	
cis-1,3-dichloro-propene	50	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
trans-1,3-dichloropropene	50	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
2,4-dimethyl-phenol	46	0	--	--	--	--	--	320	--	320	Not detected in LFI sampling.	
Diethylphthalate	46	5	0.39	--	--	--	--	72.2	--	72.2	No WAC 173-340 action levels.	Low detection rate and maximum detection < HH regulatory limit.
Dimethyl-phthalate	46	0	--	--	--	--	--	16,000	--	16,000	Not detected in LFI sampling.	
Di-n-butyl-phthalate	46	7	4.3	--	--	--	--	11.4	--	11.4	No WAC 173-340 action levels.	Low detection rate and detected value < HH regulatory limit.
2,4-dinitro-phenol	46	0	--	--	--	--	--	0.128	--	0.128	Not detected in LFI sampling.	
2,4-dinitro-toluene	46	0	--	--	--	--	--	1.3E-3	--	1.3E-3	Not detected in LFI sampling.	
2,6-dinitro-toluene	46	0	--	--	--	--	--	16	--	16	Not detected in LFI sampling.	
4,6-dinitro-2-methylphenol	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Di-n-octyl-phthalate	46	0	--	--	--	--	--	320	--	320	Not detected in LFI sampling.	
Ethyl benzene	50	0	--	--	--	--	--	6.05	--	6.05	Not detected in LFI sampling.	
Bis(2-ethyl hexyl)phthalate	46	4	5.2	--	--	--	--	6.0	--	6.0	No WAC 173-340 action levels.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Fluoranthene	46	1	0.067	--	--	--	--	631	--	631	Low detection rate in LFI sampling and detected value below screening value.	
Fluorene	92	0	--	--	--	--	--	12.4	--	12.4	Not detected in LFI sampling.	
Hexachloro-benzene	46	0	--	--	--	--	--	2.41E-3	--	2.41E-3	Not detected in LFI sampling.	
Hexachloro-butadiene	46	0	--	--	--	--	--	0.561	--	0.561	Not detected in LFI sampling.	
Hexachloro-cyclopentadiene	46	0	--	--	--	--	--	50	--	50	Not detected in LFI sampling.	
Hexachloro-ethane	46	0	--	--	--	--	--	0.249	--	0.249	Not detected in LFI sampling.	
Hexane[j]	1	1	0.024	--	--	--	--	480	--	480	No WAC 173-340 action levels.	Very low detected value compared to the human health regulatory limit.
2-hexanone	50	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Indeno (1,2,3-cd) pyrene	46	0	--	--	--	--	--	0.012	--	0.012	Not detected in LFI sampling.	
Isophorone	46	0	--	--	--	--	--	92.1	--	92.1	Not detected in LFI sampling.	
Methylene chloride	50	18	0.076	--	--	--	--	0.254	--	0.254	No WAC 173-340 action levels.	Maximum detection less than human health regulatory limit.
2-methyl naphthalene	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
4-methyl-2-pentanone (MIBK)	50	0	--	--	--	--	--	12.8	--	12.8	Not detected in LFI sampling.	
2-methyl phenol (cresol, o-)	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
4-methyl phenol (cresol, p-)	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Naphthalene	46	0	--	--	--	--	--	4.46	--	4.46	Not detected in LFI sampling.	
2-nitroaniline	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
3-nitroaniline	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
4-nitroaniline	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
2-nitrophenol	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
4-nitrophenol	46	0	--	--	--	--	7	--	7	--	Not detected in LFI sampling.	
n-nitroso-di-n-dipropylamine	46	0	--	--	--	--	--	5.6E-5	--	5.6E-5	Not detected in LFI sampling.	
n-nitrosodi-phenylamine	46	1	0.11	--	--	--	--	17.9	--	17.9	Low detection rate in LFI sampling and detected value below screening value.	
Nitrobenzene	46	0	--	--	--	--	--	5.11E-2	--	5.11E-2	Not detected in LFI sampling.	
Pentachloro-phenol	46	2	0.92	--	3	6	4.5	8.87E-3	3	8.87E-3	Low detection rate.	
Phenanthrene	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Phenol	46	0	--	--	--	--	--	43.9	--	43.9	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Pyrene	46	2	0.065	--	--	--	--	480	--	480	Low detection rate in LFI sampling and detected value below screening value.	
Styrene	50	0	--	--	--	--	--	0.033	--	0.033	Not detected in LFI sampling.	
Tetrachloro-ethene	50	0	--	--	--	--	--	9.1E-3	--	9.1E-3	Not detected in LFI sampling.	
1,1,2,2-tetrachloro-ethane	50	0	--	--	--	--	--	1.23E-3	--	1.23E-3	Not detected in LFI sampling.	
Toluene	3	3	3.7	--	200	--	--	7.27	200	7.27	Maximum detection much less than regulatory limits.	
1,2,4-trichloro-benzene	46	0	--	--	--	--	--	2.98	--	2.98	Not detected in LFI sampling.	
1,1,1-trichloro-ethane	50	0	--	--	--	--	--	1.58	--	1.58	Not detected in LFI sampling.	
1,1,2-trichloro-ethane	50	0	--	--	--	--	--	4.27E-3	--	4.27E-3	Not detected in LFI sampling.	
Trichloroethene (TCE)	50	0	--	--	--	--	--	0.026	--	0.026	Not detected in LFI sampling.	
2,4,5-trichloro-phenol	46	0	--	--	--	--	--	57.5	--	57.5	Not detected in LFI sampling.	
2,4,6-trichloro-phenol	46	0	--	--	--	--	--	0.049	--	0.049	Not detected in LFI sampling.	
Vinyl acetate	30	0	--	--	--	--	--	8,000	--	8,000	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Vinyl chloride	50	0	--	--	--	--	--	1.84E-4	--	1.84E-4	Not detected in LFI sampling.	
Xylenes (total)	50	0	--	--	--	--	--	91.4	--	91.4	Not detected in LFI sampling.	
Pesticides												
Aldrin	46	0	--	--	--	--	0.1	0.0051	0.1	0.0051	Not detected in LFI sampling.	
Alpha-BHC	46	0	--	--	--	--	6	0.013	6	0.013	Not detected in LFI sampling.	
Alpha-chlordane	46	0	--	--	--	1	2.7	0.25	1	0.25	Not detected in LFI sampling.	
Beta-1,2,3,4,5,6-hexachloro-cyclohexane	46	0	--	--	--	--	--	0.0486	--	0.0486	Not detected in LFI sampling.	
Delta-BHC	46	0	--		--	--	--	--	--	--	Not detected in LFI sampling.	
Dichlorodiphenyl dichloroethane (DDD)	46	0	--	--	--	--	0.75 (total)	0.365	0.75 (total)	0.365	Not detected in LFI sampling.	
Dichlorodiphenyl dichloro ethylene (DDE)	46	0	--	--	--	--	0.75 (total)	0.257	0.75 (total)	0.257	Not detected in LFI sampling.	
Dichlorodiphenyl trichloro ethane (DDT)	46	0	--	--	--	--	0.75 (total)	0.257	0.75 (total)	0.257	Not detected in LFI sampling.	
Dieldrin	46	0	--	--	--	--	0.07	0.0054	0.07	0.0054	Not detected in LFI sampling.	
Endosulfan I	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Endosulfan II	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Endosulfan sulfate	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Endrin	46	0	--	--	--	--	0.2	2	0.2	2	Not detected in LFI sampling.	
Endrin aldehyde	16	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Endrin ketone	46	0	--	--	--	--	--	--	--	--	Not detected in LFI sampling.	
Gamma-BHC (Lindane)	46	0	--	--	--	--	6	0.067	6	0.067	Not detected in LFI sampling.	
Gamma-chlordane	46	0	--	--	--	1	2.7	--	1	--	Not detected in LFI sampling.	
Heptachlor/ heptachlor epoxide (total)	46	0	--	--	--	--	0.4	0.0096	0.4	0.0096	Not detected in LFI sampling.	

Table 1-8. COC Soil Screening for Chemical Constituents. (15 Pages)

COPC	Number of Samples	Number of Detects	Max Detected Value (mg/kg)	Site Back-ground Value (mg/kg)	Ecological Soil Screening Values[a] (mg/kg)			Human Health Action Level[b] (mg/kg)	COPC Screening Value (mg/kg)		Ecological Exclusion	Human Health Exclusion
					P	SB	WL		Eco	HH		
Methoxychlor	46	0	--	--	--	--	--	40	--	40	Not detected in LFI sampling.	
Toxaphene	46	0	--	--	--	--	--	0.079	--	0.079	Not detected in LFI sampling.	

[a] Ecological soil screening values in accordance with WAC 173-340-900, Table 749-3.
[b] The most conservative of the direct exposure and groundwater protection values are used.
[c] The MTCA ecological screening Table 749-3 provides different values for arsenic III and arsenic V. The laboratories used cannot make these isomer distinctions; therefore, the most conservative value has been adopted.
[d] The statewide arsenic background value of 20 mg/kg (Table 2 of WAC 173-340-740) has been adopted for the 100 Areas.
[e] Hanford specific background value was not evaluated during the background study. The value shown is from Ecology (1994).
[f] Chromium is measured as total chromium.
[g] The regulatory action level is below background. The screening value used is background.
[h] Values shown for aroclors are total values to be applied to all detected PCB mixtures within each category.
[i] PCB mixture values, calculated in accordance with WAC 173-340-740(3)(a)(iii)(B).
[j] Gasoline range organic. Stated action level also requires that the concentration shall not exceed residual saturation at the surface.

-- = Value not available.
BCG = biota concentration guide (DOE 2002)
Eco = ecological protection value
HH = human health protection value
P = plants
SB = soil biota
TBD = to be determined
WL = wildlife

Table 1-9. 100-B/C Area Final COC List. (2 Pages)

Contaminant	Retention Logic
Radionuclides	
Americium-241	100 Area contaminant identified by process knowledge and historical sampling and analyses
Carbon-14	
Cesium-137	
Cobalt-60	
Europium-152	
Europium-154	
Europium-155	
Nickel-63	
Plutonium-238	
Plutonium-239/240	
Silver-108m	100 Area contaminant uniquely associated with the burial grounds (DOE-RL 2001a)
Strontium-90	100 Area contaminant identified by process knowledge and historical sampling and analyses
Technetium-99	
Thorium-232	
Tritium	
Uranium-233/234	
Uranium-235	
Uranium-238	
Inorganics (Metals)	
Barium	100 Area contaminant identified by process knowledge and historical sampling and analyses
Cadmium	
Chromium (total)	
Chromium (VI)	
Lead	
Manganese	
Mercury	
Nickel	
Selenium	
Silver	
Uranium	

Table 1-9. 100-B/C Area Final COC List. (2 Pages)

Contaminant	Retention Logic
Organics	
Aroclor-1254	Detected in LFIs above screening levels
Aroclor-1260	100 Area contaminant identified by process knowledge and historical sampling and analyses
Phthalates	
SVOAs (screen)[a]	
VOAs (screen)[a]	

[a] Petroleum hydrocarbons and pesticides will be detected in VOAs and SVOAs.

The biota concentration guides (BCGs) in Table 1-7 are radionuclide soil screening levels considered protective of terrestrial and aquatic biota. This table also lists human health radiological lookup values that are human health soil action levels based on a dose standard of 15 mrem/yr above background using the rural-residential scenario provided in the 100 Area RDR/RAWP (DOE-RL 2002). The last two columns provide the rationale for excluding contaminants based on ecological or human health criteria, respectively.

The radionuclides were screened from the COPC list based on low (or no) rate of detection and half-life. The COPCs were excluded if their half-lives were less than 3 years. Using these screening criteria, 17 radionuclides were retained and are listed in Table 1-9. Although not detected during the LFI sampling and analyses, tritium and technetium-99 were retained as COCs because they were detected in groundwater. This is attributed to their low distribution coefficient values (they are not differentially attracted to soil particles and move with the water). Carbon-14 was also retained as a COC, despite its low rate of detection because it is a COC in the 100 Area RDR/ RAWP (DOE-RL 2002). Silver-108m was not included in the LFI sampling, nor was it detected in over 35,000 individual Hanford Environmental Information System records. Nevertheless, it was identified as a COC in the 100 Area burial grounds SAP (DOE-RL 2001a) and is therefore retained as a COC for the pilot study.

Table 1-8 is similar to Table 1-7, with several notable exceptions. A three-part column entitled "Ecological Screening Values" replaces the "BCG" column in Table 1-7. The categories represent soil screening values that are protective of terrestrial plants (P), soil biota (SB), and wildlife (WL), respectively obtained from Table 749-3 of WAC 173-340-900. The human health soil action level is the most conservative concentration deemed protective for unrestricted land use (DOE-RL 2002). The contaminants listed in Table 1-8 consist of inorganic metals, organics, and pesticides. The LFI sampling included analyses for 31 metals, 107 organics (SVOAs and VOAs), and 21 pesticides. Characterization for so many nonradionuclides is not an indication that these chemicals were used in the 100-B/C Area; rather, it reflects the comprehensive CERCLA characterization process employed in the LFI characterization.

Chemicals were excluded based on low (or no) rate of detection and because WAC 173-340 does not provide human health or ecological action levels. They were also excluded because they were not detected above the most restrictive level given in the 100 Area burial grounds SAP (DOE-RL 2001a) or Table 749-3 action levels during LFI sampling and analysis. The chemicals remaining after this screening process are listed in Table 1-9.

1.10.1 Comparison to WAC 173-340-900, Table 749-3

In August 2001, the *Model Toxics Control Act* (MTCA) was revised to include requirements for a terrestrial ecological evaluation as part of the process for determining whether remediation is needed. Table 749-3 of WAC 173-340-900 provides soil screening levels for 78 contaminants or classes of chemicals that are considered to pose a threat to terrestrial ecological receptors. They consist of selected metals, pesticides, and chlorinated and other non-chlorinated organics. From this list, 24 were not explicitly analyzed for in the LFI sampling. This number is misleading because the LFI sampling effort provides information on the possible presence of most of these contaminants.

The Table 749-3 (WAC 173-340-900) contaminants that were not analyzed in the LFI sampling are identified and discussed below:

- **Boron** – This element is a neutron absorber, and is used to control or stop nuclear chain reactions. Boron was used in a boric acid liquid-based quencher system during reactor operations. Due to its function, it was not available to the environment. It was later replaced by a system that used boron balls. The boron in this system was part of an alloy that was not available as a contaminant to the environment.

- **Bromine** – There is no known process in the 100-B/C Area that used this highly volatile liquid.

- **Fluorine** – There is no known process in the 100-B/C Area that used this highly volatile gas.

- **Iodine** – There was no known process that brought this highly volatile solid into the 100-B/C Area. The iodine produced in 100-B/C would have been radioactive. Nevertheless, iodine-129 and iodine-131 were not detected during LFI sampling.

- **Lithium** – If present in the 100-B/C Area, lithium would be in alloy form as part of the tritium targets in the burial grounds and would not be available for dispersal in the environment.

- **Molybdenum** – The Hanford Site background study did not include molybdenum. However, analyses from 200 Area soils indicate concentrations in the range of 0.5 to 1.0 mg/kg, which is below the lowest concentration in Table 749-3 of WAC 173-340-900.

- **Technetium** – Technetium is only present as a radionuclide and has been identified as a radiological COC.

- **Tin** – Tin in the 100-B/C Area would be expected to exist as an alloy in solder and would not be available to the environment. The Hanford Site background level for tin is 5 to 10 mg/kg.

- **Uranium** – Uranium represents a chemical and radionuclide concern and will, therefore, be retained as a radiological and chemical COC.

The other contaminants in Table 749-3 of WAC 173-340-900 that were not analyzed for in the LFI sampling are either chlorinated or non-chlorinated organic compounds and would have been identified as detected tentatively identified compounds if they had been present during LFI sampling.

The sampling process for the organic contaminants will include VOA and SVOA suite analyses to request information on the routine list of 33 VOAs and 66 SVOAs on the current contract laboratory program list. Other detectable peaks observed in the chromatograms would be identified as tentatively identified compounds.

Some contaminants (e.g., tritium and technetium-99) have been detected in the groundwater under the 100-B/C Area but are not detected in the soils of the waste sites. These contaminants move with the water and do not tend to sorb onto soil particles. Table 1-10 lists the contaminants that are historically seen in groundwater above regulatory limits (PNNL 2002).

Table 1-10. COCs Historically Present in Groundwater Plumes.

COC	Retention Rationale
Nitrate	*Contaminants historically detected in groundwater and either* currently, or in the recent past, at levels above the drinking water standards
Chromium (VI)	
Strontium-90	
Tritium	
Technetium-99	

It is noted that groundwater cleanup action levels have not been identified. This is because the pilot study does not evaluate groundwater contamination levels for remedial decision making, but the pilot study will assess the potential impacts of groundwater contamination upon humans and resident biota. Nevertheless, action levels are provided in Table 3-6 to provide the basis for meeting groundwater sample data quality requirements.

1.11 CURRENT AND POTENTIAL FUTURE LAND USE

The current and potential future uses for the land in the immediate vicinity of the site under investigation are summarized in Table 1-11. This information is needed later in the DQO process to support the evaluation of decision error consequences.

Table 1-11. Current and Potential Future Land Use.

Access to the Hanford Site is currently strictly controlled and the public is not allowed onsite. The 100 Areas are adjacent to the Columbia River in the northern portion of the Site. Nine retired reactor facilities are located in six reactor areas. The 100-B/C Area is the first area downstream from the Vernita Bridge. The 100-B/C Area is located within the area designated as the Columbia River Corridor under the preferred alternative of the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999). This "corridor" includes a quarter-mile buffer zone from the river with the land-use designation of "preservation," to protect cultural and ecological resources. The remainder of the area is designated as "conservation (mining)."
The preservation land-use designation in the final environmental impact statement is defined as "…an area managed for the preservation of archeological, cultural, ecological, and natural resources. No new consumptive uses (i.e., mining or extraction of non-renewable resources) would be allowed within this area. Limited public access would be consistent with resource preservation. Includes activities related to preservation uses." The conservation (mining) designation is defined as "…an area reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes) could occur as a special use (i.e., a permit would be required) within appropriate areas. Limited public access would be consistent with resource conservation. Includes activities related to conservation (mining), consistent with the protection of archeological, cultural, ecological, and natural resources."
The reactors and areas involved with remediation activities are considered pre-existing, nonconforming use in the preservation land-use designation. These areas would retain the "nonconforming-use" designation until restoration is complete and the Columbia River Corridor is returned to a nondeveloped, natural condition. The ROD for the surplus reactor environmental impact statement (DOE 1992) calls for the reactor buildings to be demolished and the reactor blocks moved to the Central Plateau; however, this action might not take place until 2068 or until a new Tri-Party Agreement milestone is negotiated.

1.12 PRELIMINARY ACTION LEVELS AND ARARs

The preliminary action levels that apply to the COCs are identified in Table 1-12. The action level is defined as the threshold value that provides the criterion for choosing between alternative actions (AAs). The action levels presented in Table 1-12 are based on applicable or relevant and appropriate requirements (ARARs) under Federal and state regulations or to-be-considered (TBC) guidance. The ARARs are preliminarily identified in the 100 Area RDR/RAWP (DOE-RL 2002) and interim ROD (EPA et al. 1995). The ARARs and TBC guidance of particular importance to the ecological evaluation include WAC 173-340-7490 through -7493; WAC 173-340-900, Table 749-3; the *Endangered Species Act of 1973*; the *Migratory Bird Treaty Act*; the *National Environmental Policy Act of 1969* (NEPA); EPA guidance on ecological risk assessments (EPA 1998) and on ecological risk assessment for superfund (EPA 1997); and DOE's guidance on evaluation of ecological impacts associated with radionuclides (DOE 2002).

Table 1-12. List of Preliminary Action Levels.

Media	Preliminary ARARs and TBCs	Action Levels
Soils		
Human Health Exposures – Radionuclides		
Shallow zone (0 to 4.6 m [15 ft] below ground surface)	15 mrem/year above background (EPA 1995)	Cumulative dose for rural-residential exposure as defined in DOE-RL (2001a)
Human Health Exposures – Nonradionuclides		
Shallow zone (0 to 4.6 m [15 ft] below ground surface)	WAC 173-340-705 (MTCA Method B)	Contaminant-specific
Ecological Exposures – Radionuclides		
Shallow zone (0 to 4.6 m [15 ft] below ground surface)	DOE (2002) ecological BCGs	Contaminant-specific
Ecological Exposures – Nonradionuclides		
Shallow zone (0 to 4.6 m [15 ft] below ground surface)	WAC 173-340-900, Table 749-3	Chemical-specific for wildlife, plants, and soil biota
Biota		
Biota Body Tissues – Radionuclides and Nonradionuclides		
Ground surface	N/A	Weight of evidence evaluation in accordance with Section 1.12.1
River water biota	N/A	
Surface Water		
Radionuclides and Nonradionuclides		
Surface Water	DOE-RL 2002 (RDR/RAWP, RAGs)	Contaminant-specific
Groundwater		
Radionuclides and Nonradionuclides		
Groundwater	DOE-RL 2002 (remedial design report, RAGs)	Contaminant-specific

1.12.1 Weight of Evidence Evaluation

Guidance on acceptable concentrations for chemical contaminants (action levels or ARARs) has not been established for most species of biota. One approach to assessing the potential impact of contaminants in study area biota compares their contaminant concentrations to contaminant concentrations in analogous biota at uncontaminated reference locations, as well as other relevant information and application of risk assessment methods. Judgments are then based on a "weight of evidence evaluation." The basis for biological screening endpoints considered in the weight of evidence evaluation is discussed in DQO Step 3. Data quality requirements for biota tissue analyses are associated with the detection limits established by EPA, as shown in Table 3-7.

1.13 EXPOSURE SCENARIOS AND RISK EVALUATION

1.13.1 Exposure Scenarios

Exposure scenarios describe how human and ecological receptors can come into contact with contamination in the environment. The scenarios should be based on realistic uses of a specific location and its resources by the receptors. Cleanup decisions are based on the level of potential risk associated with exposure to contamination as defined by the scenarios.

There are several exposure scenarios that have been selected as appropriate for determining if the remediation of the 100-B/C Area waste sites is protective of humans and the environment. They are described briefly in Table 1-13.

Table 1-13. Exposure Scenarios. (2 Pages)

Scenario No.	Exposure Scenario Description
1	***Rural-Residential Exposure Scenario*** This resident is assumed to consume crops raised in a backyard garden; consume animal products, such as meat and milk from locally raised livestock or meat from game animals (including fish); and live in a residence on the waste site. The exposure pathways considered in estimating dose from radionuclides in soil are inhalation; soil ingestion; ingestion of crops, meat, fish, drinking water, and milk; and external gamma exposure. This individual is conservatively assumed to spend 80% of his/her lifetime on site. This scenario applies to the upland area of the 100-B/C Area where most of the waste sites are located. This exposure scenario is the basis for determining compliance with the 15 mrem/yr radiological dose standard for the remediated waste sites as specified by the ROD.
2	***Avid Recreationalist Exposure Scenario*** An avid recreationalist is a person who spends a considerable amount of time in the area on recreational pursuits, such as hunting, fishing, boating, swimming, camping, hiking, and picnicking. This scenario would apply primarily to the riparian and near river shore areas, with some involvement of the upland. The details of this scenario have not been specified as yet; however, it is expected to produce less exposure than the rural-residential scenario.
3	***Native American Exposure Scenario*** Native American subsistence scenarios describe uses of resources that are not completely addressed in a rural-residential or avid recreationalist scenario. These uses could include the use of native plants for medicinal purposes and a sweat lodge. Since the Tribes use the resources differently, it is expected that each Tribe may want to define their own subsistence scenario. The pilot study will address these scenarios.

Table 1-13. Exposure Scenarios. (2 Pages)

Scenario No.	Exposure Scenario Description
4	*Terrestrial Ecological Exposure Scenario* The terrestrial ecological exposure scenario is defined by the plants and animals that inhabit the upland areas and whose home ranges are such that they would spend a significant amount of their time on or near former waste sites in the 100-B/C Area. The WAC 173-340-7490 terrestrial evaluation procedure defines feeding guilds of a wildlife exposure model that are applicable to the 100-B/C Area: plants, soil biota (soil invertebrates), avian predator, mammalian predator, and herbivore that are appropriate for the 100-B/C Area. This scenario will be addressed by this DQO process.
5	*Riparian Ecological Exposure Scenario* The riparian ecological exposure scenario is defined by the plants and animals inhabiting the riparian zone and whose home ranges are such that they would spend a significant amount of their time in this area. The feeding guilds evaluated in the upland area are also applicable in the riparian zone and will include appropriate representative species (i.e., plants, soil biota [soil invertebrates]), avian predator, mammalian predator, and herbivore. This scenario will be addressed by this DQO process.
6	*Near-Shore Aquatic Ecological Exposure Scenario* This scenario is defined by the biota inhabiting the near shore aquatic environment that spend a significant amount of their time in this area. Appropriate representatives of the feeding guilds present will be evaluated. They include plants, bottom dwelling invertebrates, and vertebrate predators. This scenario will be addressed by this DQO process.

1.13.2 Risk Evaluation

The exposure scenarios can be used with the environmental contaminant data to estimate risk to receptors and/or determine compliance with regulatory cleanup requirements. This section discusses how the 100-B/C Area waste site cleanup verification packages (CVPs) demonstrate compliance with the regulatory requirements as defined in the ROD (EPA et al. 1995).

1.13.2.1 Human Surface Exposures (0 to 4.6 m [15 ft]). Demonstrating the protection of human health for the shallow zone (<4.6 m [<15 ft]) at the individual 100-B/C waste sites has been evaluated against the cumulative 15 mrem/yr dose standard using the RESidual RADioactivity (RESRAD) dose model with the rural-residential scenario. The concentrations of nonradionuclides have been compared against the WAC 173-340-705 Method B unrestricted use cleanup values. This comparison shows that the surface exposure requirements are met for each remediated waste site (Doctor et al. 2002). In addition, the carcinogenic nonradionuclides are evaluated against the 10^{-6} risk limit for individual contaminants and the 10^{-5} cumulative risk limit for multiple contaminants. Each waste site must meet these criteria in order to be closed out and backfilled. Therefore, if each waste site is cleaned up to these limits, then the whole area also meets the cleanup limits. Consequently, the demonstration of protectiveness would include a summary of all of the individual site closeout data.

1.13.2.2 Groundwater (Drinking Water) Protection for Humans. Protectiveness of human health from exposure to groundwater is assessed using RESRAD and the rural-residential scenario. The scenario includes the contribution from residual contaminants in the vadose zone to the groundwater, assuming 30 in./yr of irrigation water.

1.13.2.3 Surface (Upland) Ecological Receptors. WAC 173-340-7490 (et seq.) establishes cleanup standards using an ecological risk assessment approach that incorporates representative receptor species and pathways. The contaminants considered include metals, pesticides, chlorinated organics, non-chlorinated organics, and petroleum compounds. Radionuclides are not included and must be evaluated using a different assessment process. WAC 173-340-7490 (et seq.) provides a graded approach to evaluating the ecological impacts from waste sites. Exclusions from the terrestrial ecological evaluation are provided for sites where no pathways exist, such as waste sites that are covered by buildings, pavement, or other physical barriers that would prevent plants or wildlife from becoming exposed. Another exclusion is provided for contaminated soil that is, or will be, located below 4.6 m (15 ft).

For sites that do not qualify for any of the exclusions, a site-specific terrestrial ecological evaluation must be conducted. A simplified evaluation is provided for those sites that do not have a substantial potential for a significant adverse ecological threat (WAC 173-340-7492). For sites that do not qualify for the simplified evaluation, a more stringent site-specific evaluation (WAC 173-340-7493) must be conducted using one of several methods provided. The method Ecology focuses on is a wildlife exposure model. Using the prescribed wildlife exposure model, Ecology calculated soil cleanup levels that are "expected to be protective at any MTCA site" and provided these levels in a table within the new rule (WAC 173-340-900, Table 749-3). Waste sites can be evaluated against this table and, if soil concentrations are below these values, the site can be eliminated from further consideration.

The effects of residual radiological contamination on terrestrial receptors can be evaluated using DOE's graded approach (DOE 2002). This standard is modeled after EPA methodology and uses a screening approach to determine if radiological exposures to biota exceed prescribed protective thresholds. The screening step uses a table of soil concentrations referred to as BCGs that are judged to be protective of the most sensitive terrestrial organisms, assuming a dose of 0.1 rad/day for animals and 1.0 rad/day for plants. Soil concentrations that are less than the BCGs are not considered to pose a threat to terrestrial receptors. If the tabled values are exceeded, the standard uses a graded approach to evaluate exposures to receptors by considering site specific conditions such as the limiting radionuclides, the most sensitive receptors, the size of the area, availability of the contamination, and home range of the receptors present.

1.13.2.4 Riparian Zone Protection for Human and Ecological Receptors. The concept of the rural-residential scenario is not credible for human receptors exposed in the riparian zone based on the size of the area and terrain. Recreational or hunter-gatherer exposures would be more appropriate, and *Columbia River Comprehensive Impact Assessment* (DOE-RL 1998) exposure scenarios may apply.

The ecological evaluation will require additional sampling of ecological receptors in completed pathways to provide a credible evaluation. The WAC 173-340-7490 (et seq.) terrestrial plant and wildlife soil screening process will be evaluated for protection of riparian species. Following this graded approach, a combination of site-specific measurement endpoints may be used to address the issues of protectiveness in the riparian zone. If soil concentrations do not exceed values in WAC 173-340-900, Table 749-3 of the new rule (see Table 1-9 of this document), then ecological receptors will not be considered at risk. If soil concentrations exceed values in this table, additional evaluation will be conducted as prescribed in WAC 173-340-7490 (et seq.).

One of the alternative methods for evaluation is to conduct site-specific field studies that involve hypothesis testing. For example, some indicator of effect on a population in the study area (e.g., reproductive success) would be compared to a population at a reference location. Another alternative method prescribed in the rule is a "weight of evidence approach." This could include a balance of literature, field, and laboratory data. Where appropriate, sampling results will be compared to applicable standards, benchmarks, or guidelines. Additionally, biota sampling will include the analyses of contaminant tissue burdens and measurements of plant or animal health at the study site and compared to the reference site(s). The evaluation of biological conditions will include a synthesis of this information (i.e., weight of evidence) to evaluate whether ecological receptors are at risk of significant adverse effects from residual contamination as defined in WAC 173-340-7490.

1.13.2.5 Surface Water (Near-Shore) Protection for Human and Ecological Receptors. The protection of surface water is closely related to the protection of groundwater. If contamination is not predicted to reach groundwater in 1,000 years, then there is no impact to surface water in that time period. Because there are no specific surface water concentration limits for radionuclides, the maximum contamination limits from the *Safe Drinking Water Act* (for protection of groundwater) are considered protective of humans. For nonradionuclides, there are specific surface water limits in terms of the ambient water quality criteria (AWQC), which are assumed to be generally protective of all aquatic life. The AWQC are used to calculate conservative limits for soil that are based on a fixed dilution-attenuation factor and the "100 times rule" (or its replacement) for groundwater. If the statistical value is less than the soil limit, then protectiveness of surface water is demonstrated. If the statistical value is greater than the soil limit, then a tiered approach is used to further refine the evaluation. In these evaluations, the standards for surface water protection are generally more stringent than groundwater standards for the same contaminant.

The ecological evaluation will follow the guidance of DOE (2002) for radiological contamination. The screening values for aquatic receptors are based upon a dose to the most sensitive organism of 1 rad/day. For nonradionuclides, the AWQC will be used as a screening tool. If water concentrations do not exceed the AWQC, then it is likely aquatic receptors are not being adversely affected and the results will be used to support a weight of evidence approach to determine protectiveness. Additionally, biota sampling will include the analyses of contaminant tissue burdens and measurements of plant or animal health at the study site and compared to a reference site(s). The evaluation of biological conditions will include a synthesis of this information (i.e., weight of evidence) to evaluate whether ecological receptors are at risk of "significant adverse effects from residual contamination" as defined in WAC 173-340-7490.

1.14 DATA QUALITY OBJECTIVE APPROACH

This DQO process is being performed to determine if the residual contamination levels in the 100-B/C Area are protective of human health and protective of the upland, riparian, and near-shore river ecological environments.

Because this DQO effort is a pilot study, it will serve as a model for the other 100 Area reactor sites, which are in various stages of decommissioning and remediation. A SAP will be developed after completion of this DQO process to include the characterization requirements needed to support the follow-up human health and ecological risk assessment. The initial field data will be evaluated and may be supplemented with a second phase, if necessary. The evaluation will also consider the need for periodic or long-term monitoring.

1.15 PROBLEM STATEMENT

In order to assess whether the 100-B/C Area is protective of human health and the environment, data regarding soil, water, and biota contamination levels in the upland areas, the riparian zone, and the near-shore river environments are needed.

2.0 STEP 2 – IDENTIFY THE DECISION

The purpose of DQO Step 2 is to define the principal study questions (PSQs) that need to be resolved to address the problem identified in DQO Step 1 and the AAs that would result from the resolution of the PSQs. The PSQs and AAs are then combined into decision statements (DSs) that express a choice among AAs. Table 2-1 presents the task-specific PSQs, AAs, and resulting DSs. This table also provides a qualitative assessment of the severity of the consequences of taking an AA if it is incorrect. This assessment takes into consideration human health and the environment (flora/fauna) and political, economic, and legal ramifications. The severity of the consequences is expressed as low, moderate, or severe.

Table 2-1. Summary of DQO Step 2 Information. (3 Pages)

PSQ-AA #	Alternative Action	Description of Consequences of Implementing the Wrong Alternative Action	Severity of Consequences (Low/Moderate/Severe)
PSQ #1 – Is the soil radiologically contaminated?			
1-1	Remove radiologically contaminated soil.	The 100-B/C Area may be inappropriately remediated, resulting in unnecessary expenditure of funds and/or destruction of habitat.	Moderate
1-2	Provide institutional controls to prevent access to contaminated soils.	Access to the 100-B/C Area would be inappropriately restricted.	Low
1-3	Perform additional investigation.	Remedial decisions would be made without a complete data set	Moderate
1-4	Monitor conditions in the 100-B/C Area until land transfer.	The 100-B/C Area land ownership may be inappropriately transferred without remedial actions beyond those already taken. This could result in risk of potential exposure to humans and environment.	Moderate
DS #1 – Determine if the residual soil is radiologically contaminated and remove additional contaminated soil, provide institutional controls to prevent access to contaminated soils, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.			
PSQ #2 – Is the soil chemically contaminated?			
2-1	Remove chemically contaminated soil.	The 100-B/C Area may be inappropriately remediated resulting in unnecessary expenditure of funds and/or destruction of habitat.	Moderate
2-2	Provide institutional controls to prevent access to contaminated soils.	Access to the 100-B/C Area would be inappropriately restricted.	Low

Table 2-1. Summary of DQO Step 2 Information. (3 Pages)

PSQ-AA #	Alternative Action	Description of Consequences of Implementing the Wrong Alternative Action	Severity of Consequences (Low/Moderate/Severe)
2-3	Perform additional investigation.	Remedial decisions would be made without a complete data set.	Moderate
2-4	Monitor conditions in the 100-B/C Area until land transfer.	The 100-B/C Area land ownership may be inappropriately transferred without remedial actions beyond those already taken. This could result in risk of potential exposure to humans and environment.	Moderate
DS #2 – Determine if the residual soil is chemically contaminated and remove additional contaminated soil, provide institutional controls to prevent access to contaminated soils, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.			
PSQ #3 – Are biota radiologically contaminated?			
3-1	Perform additional soil remediation.	The 100-B/C Area may be inappropriately remediated resulting in unnecessary expenditure of funds and/or destruction of habitat.	Moderate
3-2	Construct bio-barriers.	Access to area could be inappropriately restricted; habitat could be degraded and unnecessary expenditure of funds.	Moderate
3-3	Perform additional investigation.	Remedial decisions would be made without a complete data set.	Moderate
3-4	Monitor conditions in the 100-B/C Area until land transfer.	The 100-B/C Area land ownership may be inappropriately transferred without remedial actions beyond those already taken. This could result in risk of potential exposure to humans and environment.	Moderate
DS #3 – Determine if the biota are radiologically contaminated, and perform additional soil remediation, construct bio-barriers, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.			
PSQ #4 – Are biota chemically contaminated?			
4-1	Perform additional soil remediation.	The 100-B/C Area may be inappropriately remediated resulting in unnecessary expenditure of funds and/or destruction of habitat.	Moderate
4-2	Construct bio-barriers.	Access to could be inappropriately restricted; habitat could be degraded and unnecessary expenditure of funds.	Moderate
4-3	Perform additional investigation.	Remedial decisions would be made without a complete data set.	Moderate

Table 2-1. Summary of DQO Step 2 Information. (3 Pages)

PSQ-AA #	Alternative Action	Description of Consequences of Implementing the Wrong Alternative Action	Severity of Consequences (Low/Moderate/Severe)
4-4	Monitor conditions in the 100-B/C Area until land transfer.	The 100-B/C Area land ownership may be inappropriately transferred without remedial actions beyond those already taken. This could result in risk of potential exposure to humans and environment.	Moderate
DS #4 – Determine if the biota are chemically contaminated, and perform additional soil remediation, construct bio-barriers, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.			

3.0 STEP 3 – IDENTIFY INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the type of data needed to resolve each of the DSs identified in DQO Step 2. The data may already exist or may be derived from computational or surveying/sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limit [PQL] requirements, precision, and accuracy) are also provided in this step for any new data that need to be collected.

3.1 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL

The preliminary action level is the threshold value that provides the criteria for choosing between AAs. Table 3-1 identifies the basis (i.e., regulatory threshold or risk-based) for establishing the preliminary action level for each of the COCs. Table 3-2 identifies biological screening endpoints and data sets potentially useful in the absence of numerical action levels.

Table 3-1. Basis for Setting Preliminary Action Levels for Soils.

DS #	COCs	Basis for Setting Preliminary Action Level	Preliminary Action Levels
1	Radiological COCs	Radiological lookup values for soils based on RESRAD (ANL 2002) analyses for the applicable human health scenarios.	Table 1-7
		DOE (2002) soil values.	
2	Nonradiological COCs	WAC 173-340-705 soil cleanup levels with contaminant-specific variations.	Table 1-8
		WAC 173-340-900, Table 749-3 ecological soil screening values.	

Table 3-2. Potential Biological Screening Endpoints Used in Weight of Evidence Evaluations.

DS #	Level	Potential Screening Endpoints
3 and 4	Individual	Tissue residues, histology, necropsy/general condition (i.e., body weights, lengths, and frequency of morphological anomalies), and abiotic media comparisons
3 and 4	Population	Individual levels plus abundance (relative or absolute), reproductive success measures (e.g., recruitment rates, male-to-female ratios, pregnancy rates, and frequency of active breeders), abiotic media comparisons, and plant reproductive metrics
3 and 4	Community	Weight of evidence from individual combined with population of multiple species, and abiotic media comparisons

In the course of the data evaluation, elevated concentrations of contaminants or differences in biological screening endpoints encountered will determine whether additional screening will be required in a subsequent sampling phase. Additional biological metrics that may be used subsequent to the screening endpoints may include genetics, growth and survival rates, physiological processes, and experimental data.

3.2 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-3 specifies the information (data) required to resolve each of the DSs identified in Table 2-1 and identifies whether the data already exist. For the existing data, the source references for the data have been provided with a qualitative assessment as to whether or not the data are of sufficient quality to resolve the corresponding DS. The qualitative assessment of the existing data was based on the evaluation of the corresponding quality control data (e.g., spikes, duplicates, and blanks), detection limits, data collection methods, etc.

Table 3-3. Required Information and Reference Sources. (4 Pages)

DS #	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Add'l Info Req'd? (Y/N)
Upland Abiotic					
1	**Radiological contaminant concentrations in the 100-B/C Area soils**				
	Backfill over remediated waste sites	N	--	N/A	N/A[a]
	Excavation pit sidewalls	Y	100-B/C Area CVPs	Y	N[b]
	Excavation pit floor	Y	100-B/C Area CVPs	Y	N[b]
	Areas between and outside of waste sites	Y (limited suite of contaminants)	Carpenter (1994)	N/A	N/A[c]
2	**Chemical contaminant concentrations in the 100-B/C Area soils**				
	Backfill over remediated waste sites	N	--	N/A	N/A[a]
	Excavation pit sidewalls	Y	100-B/C Area CVPs	Y	N[b]
	Excavation pit floor	Y	100-B/C Area CVPs	Y	N[b]
	Areas between and outside of waste sites	N	--	N/A	N/A[c]

Table 3-3. Required Information and Reference Sources. (4 Pages)

DS #	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Add'l Info Req'd? (Y/N)
Upland Biota					
3	**Radiological contaminant concentrations in biota**				
	Vertebrates	N	--	--	Y
	Invertebrates	N	--	--	Y
	Plants	N	--	--	Y
4	**Chemical contaminant concentrations in biota**				
	Vertebrates	N	--	--	Y
	Invertebrates	N	--	--	Y
	Plants	N	--	--	Y
Riparian Abiotic					
1	**Radiological contaminant concentrations in the 100-B/C Area soils**				
	Areas outside of waste sites	Y (limited suite of contaminants)	PNNL (2002)	N	Y
	Discharge pipelines and outfall spillways	Y	BHI (1998a)	N	Y
	Frequent river inundation zone	N	--	N	Y
	Persistent riparian community zone	Y	Intermittently sampled in annual Hanford Site environmental reports	N	Y
2	**Chemical contaminant concentrations in the 100-B/C Area soils**				
	Areas outside of waste sites	Y (limited suite of contaminants)	PNNL (2002)	N	Y
	Discharge pipelines and outfall spillways	Y	BHI (1998a)	N	Y
	Frequent river inundation zone	N	--	N	Y
	Persistent riparian community zone	Y	Intermittently sampled in annual Hanford Site environmental reports	N	Y

Table 3-3. Required Information and Reference Sources. (4 Pages)

DS #	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Add'l Info Req'd? (Y/N)
Riparian Biota					
3	**Radiological contaminant concentrations in biota**				
	Vertebrates	N	--	--	Y
	Invertebrates	N	--	--	Y
	Plants	Y	PNL (1993), PNNL (2000a), App. 1	N	Y
4	**Chemical contaminant concentrations in biota**				
	Vertebrates	N	--	--	Y
	Invertebrates	N	--	--	Y
	Plants	Y	PNNL (2000a), App. 1	N	Y
Near-Shore River Abiotic					
1	**Radiological contaminant concentrations in the 100-B/C shoreline area**				
	Riverbed	N	--	N	Y
	Substrate #1	Y	Intermittently sampled in annual Hanford Site environmental reports	N	Y
	Seep groundwater[d]	Y	Intermittently sampled in annual Hanford Site environmental reports	N	Y
	River water[d]	N	--	N	Y
2	**Chemical contaminant concentrations in the 100-B/C shoreline area**				
	Riverbed	N	--	N	Y
	Substrate #1	Y	Intermittently sampled in annual Hanford Site environmental reports	N	Y
	Seep groundwater[d]	Y	Intermittently sampled in annual Hanford Site environmental reports	N	Y
	River water[d]	N	--	N	Y

Table 3-3. Required Information and Reference Sources. (4 Pages)

DS #	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Add'l Info Req'd? (Y/N)
Near-Shore River Biota					
3	**Radiological contaminant concentrations in biota**				
	Vertebrates	N	--	--	Y
	Invertebrates	N	--	--	Y
	Plants	N	--	--	Y
4	**Chemical contaminant concentrations in biota**				
	Vertebrates	N	--	--	Y
	Invertebrates	N	--	--	Y
	Plants	N	--	--	Y

[a] Backfill was taken from clean borrow sites for remediated waste sites.
[b] Excavation pit sidewalls and pit floors were closed out through the remediated waste site CVP process. No additional sampling or analysis is required except for the WAC 173-340-900, Table 749-3 constituents that were not covered in the cleanup verification process (DQO, Section 1.10.1). These will be accounted for by adding those constituents to the 100-B/C Area pipeline cleanup verification analytical list.
[c] These areas are excluded based on the scope definition provided in global issue #2.
[d] Data collected to support biota sampling and assessment
N/A = not applicable

This step in the DQO process is pivotal for the 100-B/C Area pilot study because it identifies the data gaps that must be filled to support the subsequent risk assessment. Because of the large scope associated with this project and the need to carefully assess variations in habitat and associated biota categories, Table 3-3 was configured to address the informational needs at a specific level rather than at a generic level. Normally the DQO process does not introduce or define the boundary (plant area) distinctions until DQO Step 4 (see Table 4-3 in Section 4.0). To specify the informational needs at this level, the specific plant areas (strata) identified in Table 4-3 were brought forward for use in Table 3-3.

3.2.1 Data Gap Analysis

The data in the reference source documents were evaluated for adequacy to support the risk assessment decision-making process outlined in Table 3-3. The data review indicated that there are no data gaps for radiological and chemical contamination in the upland areas associated with the remediated waste sites (sidewalls and pit floors). However, data gaps exist for every other category shown in Table 3-3. Therefore, it was concluded that these data gaps must be filled to support risk assessment decision making.

3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-4 identifies the DSs where existing data either do not exist or are of insufficient quality to resolve the DSs. For these DSs, Table 3-4 presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table 3-4. Information Required to Resolve the Decision Statements.

DS #	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1	Concentrations of radiological COCs in soils	Alpha, beta, and gamma COC concentrations in soils for evaluation against ARARs and PRGs Location data	RESRAD analytical modeling method for human health dose assessment DOE (2002) analytical modeling method for ecological dose assessment	Field screening with radiological detection equipment Soil sampling and laboratory analysis
2	Concentrations of nonradiological COCs in soils	Nonradiological (e.g., inorganic metals and anions, and SVOAs) COC concentrations in soils for evaluation against ARARs and PRGs Location data	EPA and state risk assessment methodology for human health and ecological assessment	Soil sampling and laboratory analysis
3	Concentrations of radiological COCs in biota	Alpha, beta, and gamma COC concentrations in biota for evaluation Location data	Weight of evidence evaluation DOE (2002)	Tissue sampling and laboratory analysis
4	Concentrations of nonradiological COCs in biota	Nonradiological (e.g., inorganic metals and anions, and SVOAs) COC concentrations in biota for evaluation Location data	Weight of evidence evaluation DOE (2002)	Tissue sampling and laboratory analysis

PRG = preliminary remediation goal

Table 3-5 presents details on the computational methods identified in Table 3-4. These details include the source and/or author of the computational method, as well as information on how the method could be applied to this study.

Table 3-5. Details on Identified Computational Methods.

DS #	Computational Method	Source/ Author	Application to Study	Satisfy Input Req't?
1	RESRAD (ANL 2002)	Argonne National Laboratory	RESRAD will be used to estimate direct human radiation exposure to account for radioactive decay.	Yes
	DOE (2002)	DOE	DOE (2002) will be used to estimate radiological dose to biota.	Yes
3 and 4	Weight of evidence evaluation DOE (2002)	EPA/state risk assessment	Basis for determination of risk to the ecosystem.	Yes

Table 3-6 identifies each of the survey and/or analytical methods that may be used to provide the required information needed to resolve each of the DSs. The possible limitations associated with each of these methods are also provided.

Table 3-6. Potentially Appropriate Survey and/or Analytical Methods.

Media	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Possible Limitations
Onsite Measurements			
Surface soils	Gamma-emitting radionuclides	Gamma detector survey	Detection limit and resolution associated with operator skill and detector type. Measures surface soils to a depth of approximately 45.7 cm (18 in.). Not suitable for alpha or beta detection.
River and groundwater	Conductivity (groundwater influence in near-shore river water)	Conductivity meter linked to geographic information system	Random selection of sampling locations leading to sampling error.
Laboratory Samples			
Soils	All COCs	Laboratory analysis	Higher cost and longer turnaround times than onsite measurement techniques.
Biota			
Water			

3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Table 3-7 defines the analytical performance requirements for the data that need to be collected to resolve each DS. These performance requirements include the PQL and the precision and accuracy requirements for each of the COCs.

Table 3-7. Analytical Performance Requirements. (5 Pages)

COCs	CAS #	Preliminary Action Level[a] Rural-Residential 15 mrem/yr[b] (pCi/g)	Name/Analytical Technology	Target Required Quantitation Limits			Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
				Biota (pCi/g)	Soil (pCi/g)	Water (pCi/L)				
Americium-241	14596-10-2	31.1	Americium isotopic – AEA	--	1	1	±30%	70-130[c]	±30%	70-130[c]
Carbon-14	14762-75-5	2.0	Chemical separation – liquid scintillation	--	50	--	±30%	70-130[c]	±30%	70-130[c]
Cesium-137	10045-97-3	6.2	GEA	--	0.1	15	±30%	70-130[c]	±30%	70-130[c]
Cobalt-60	10198-40-0	1.4	GEA	--	0.05	25	±30%	70-130[c]	±30%	70-130[c]
Europium-152	14683-23-9	3.3	GEA	--	0.02	--	±30%	70-130[c]	±30%	70-130[c]
Europium-154	15585-10-1	3.0	GEA	--	0.02	--	±30%	70-130[c]	±30%	70-130[c]
Europium-155	14391-16-3	125	GEA	--	0.02	--	±30%	70-130[c]	±30%	70-130[c]
Nickel-63	13981-37-8	4,026	Chemical separation – liquid scintillation	--	30	--	±30%	70-130[c]	±30%	70-130[c]
Plutonium-238	13981-16-3	37.4	Plutonium isotopic – AEA	--	1	1	±30%	70-130[c]	±30%	70-130[c]
Plutonium-239/240	Pu-239/240	33.9	Plutonium isotopic – AEA	--	1	1	±30%	70-130[c]	±30%	70-130[c]
Silver-108m		2.38	GEA	--	0.01	--	±30%	70-130[c]	±30%	70-130[c]
Strontium-90	Rad-Sr	4.5	Total radioactive strontium – GPC	--	1	2	±30%	70-130[c]	±30%	70-130[c]
Technetium-99	14133-76-7	15[d]	Technetium-99 – liquid scintillation	--	15	15	±30%	70-130[c]	±30%	70-130[c]
Thorium-232	Th-232	1.3	Thorium isotopic – AEA (pCi) ICPMS (micro g)	--	1	1	±30%	70-130[c]	±30%	70-130[c]
Tritium (H-3)	10028-17-8	35.5	Tritium – liquid scintillation	--	400	400	±30%	70-130[c]	±30%	70-130[c]

Table 3-7. Analytical Performance Requirements. (5 Pages)

COCs	CAS #	Preliminary Action Level[a] Rural-Residential 15 mrem/yr[b] (pCi/g)	Name/Analytical Technology	Target Required Quantitation Limits Biota (pCi/g)	Target Required Quantitation Limits Soil (pCi/g)	Target Required Quantitation Limits Water (pCi/L)	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Uranium-233/234	13966-29-5	1.1[e]	Uranium isotopic – AEA (pCi)	--	1	1	±30%	70-130[c]	±30%	70-130[c]
Uranium-235	15117-96-1	1.0[d]	Uranium isotopic – AEA (pCi)	--	1	1	±30%	70-130[c]	±30%	70-130[c]
Uranium-238	U-238	1.1[e]	Uranium isotopic – AEA (pCi)	--	1	1	±30%	70-130[c]	±30%	70-130[c]

Table 3-7. Analytical Performance Requirements. (5 Pages)

COCs	CAS #	Preliminary Action Level[a] Method B[f] and Eco Screening Values (mg/kg)	Name/Analytical Technology	Target Required Quantitation Limits Biota (mg/kg)	Soil Low Conc. (mg/kg)	Water[d] Low Conc. (mg/L)	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Metals										
Barium	7440-39-3	132	Metals – 6010 – ICP	--	20	--	g	g	g	g
		132	EPA 200.8 – ICPMS	0.1	--	--				
Cadmium	7440-43-9	0.81	Metals – 6010 – ICP	--	0.5	0.005	g	g	g	g
			Metals – 6010 – ICP (trace)	--	0.5	0.005				
		4	EPA 200.8 – ICP	0.01	--	--				
Chromium (total)	7440-47-3	18.5[e]	Metals – 6010 – ICP	--	1	0.01	g	g	g	g
			Metals – 6010 – ICP (trace)	--	1	0.01				
		42	EPA 200.8 – ICP	0.1	--	--				
Chromium VI	18540-29-9	2.2[h]	Chromium (hexavalent) – 7196 – colorimetric	--	0.5	0.01	g	g	g	g
		N/A	--	N/A	--	--				
Lead	7439-92-1	10.2	Metals – 6010 – ICP	--	10	0.1	g	g	g	g
			Metals – 6010 – ICP (trace)	--	1	0.01				
		N/A	EPA 200.8 – ICP	0.03	--	--				

Table 3-7. Analytical Performance Requirements. (5 Pages)

COCs	CAS #	Preliminary Action Level[a] Method B[f] and Eco Screening Values (mg/kg)	Name/Analytical Technology	Target Required Quantitation Limits: Biota (mg/kg)	Target Required Quantitation Limits: Soil Low Conc. (mg/kg)	Target Required Quantitation Limits: Water[d] Low Conc. (mg/L)	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Manganese	7439-96-5	512	Metals – 6010 – ICP	--	1.5	--	g	g	g	g
		1,100	EPA 200.8 – ICP	0.05	--	--				
Mercury	7439-97-6	0.33	Mercury – 7470 – CVAA	--	N/A	0.0005	g	g	g	g
			Mercury – 7471 – CVAA	--	0.2	N/A				
		0.33	EPA 245.6 – CVAA	0.05	--	--				
Nickel	--	130	Metals – 6010 – ICP	--	4	--	g	g	g	g
		30	EPA 200.8 – ICP	0.05	--	--				
Selenium	7782-49-2	400	Metals – 6010 – ICP	--	10	0.1	g	g	g	g
		0.78	EPA 200.8 – ICP	0.2	--	--				
Silver	7440-22-4	400	Metals – 6010 – ICP	--	2	0.02	g	g	g	g
			Metals – 6010 – ICP (trace)	--	0.5	0.005				
		2	EPA 200.8 – ICP	0.01	--	--				
Uranium	--	3	Uranium total – kinetic phosphorescence analysis	--	1	--	g	g	g	g
		5	EPA 200.8 – ICP	0.01	--	--				
Organics										
Aroclor-1254	--	0.5[i]	PCBs-8082-GC	--	0.0165	--	g	g	g	g
		0.65	EPA – 645 – GC	0.001	--	--				
Aroclor-1260	--	0.5[i]	PCBs-8082-GC	--	0.0165	--	g	g	g	g
		0.65	EPA – 645 – GC	0.001	--	--				

Table 3-7. Analytical Performance Requirements. (5 Pages)

COCs	CAS #	Preliminary Action Level[a] Method B[f] and Eco Screening Values (mg/kg)	Name/Analytical Technology	Target Required Quantitation Limits: Biota (mg/kg)	Target Required Quantitation Limits: Soil Low Conc. (mg/kg)	Target Required Quantitation Limits: Water[d] Low Conc. (mg/L)	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Phthalates	--	Compound-specific	Semi-Volatile organics – 8270 – GCMS	--	0.66[j]	--	g	g	g	g
		N/A	--	0.010	--	--				
SVOAs	--	Compound-specific	Semi-Volatile organics – 8270 – GCMS	--	0.005[j]	0.005[j]	g	g	g	g
VOAs	--	Compound-specific	Volatile organics – 8260 – GCMS	--	0.005[j]	0.005[j]	g	g	g	g

[a] The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g., detection limits).
[b] The radiological cleanup criteria for the rural-residential exposure scenario is 15 mrem/yr above background. These numerical values are limiting for both human health and ecological receptors. Therefore, the ecological values are not listed on this table.
[c] Accuracy criteria for associated batch laboratory control sample percent recoveries. Except for GEA, additional analysis-specific evaluations also preformed for matrix spikes, tracers, and carriers as appropriate to the method. Precision criteria for batch laboratory replicate sample analyses.
[d] The RAG is below the target required quantitation limit. The value presented is the target required quantitation limit.
[e] The RAG is below background. The value presented is background.
[f] WAC 173-340 Method B soil values for direct exposure.
[g] Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples also performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analysis.
[h] River protection AWQC criteria derived value.
[i] Compliance is based on the sum of all aroclors detected.
[j] Phthalates, SVOA, and VOA detection limits are for "typical" analytes. Some analytes may have different detection limits and precision/accuracy values.

AEA = alpha energy analysis
CAS = Chemical Abstract Services
CVAA = cold vapor atomic absorption
GC = gas chromatograph
GCMS = gas chromatograph/mass spectrometry
GEA = gamma energy analysis
GPC = gas proportional counter
ICP = inductively coupled plasma
ICPMS = inductively coupled plasma mass spectrometer
N/A = not applicable

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

4.1 OBJECTIVE

The primary objective of DQO Step 4 is for the DQO team to identify the spatial, temporal, and practical constraints on the sampling design and to consider the consequences. This objective (in terms of the spatial, temporal, and practical constraints) assures that the sampling design results in the collection of data that accurately reflect the true condition of the site and/or populations being studied.

4.2 DEFINE THE BOUNDARIES OF THE STUDY

Table 4-1 defines the population of interest to clarify what the samples are intended to represent. The characteristics that define the population of interest are also identified.

Table 4-1. Characteristics that Define the Population of Interest.

DS #	Population of Interest	Characteristics
1 and 2	The set of environmental soil and water[a] samples within the 100-B/C Area	Activities and concentrations of radionuclides and nonradiological COCs.
3 and 4	The set of biota samples within the 100-B/C Area	
1, 2, 3, and 4	The set of environmental soil, water[a], and biota samples located within appropriate reference sites	Activities and concentrations of radionuclides and nonradiological COCs. Reference sites are selected to match the physical environment, the habitat, and the species present in a site of interest being investigated for contaminant effects. The reference sites represent area not affected by the Hanford operations within the 100-B/C Area.

[a] Supporting information, not decision-making information.

Table 4-2 defines the spatial boundaries of the decision and the domain or geographic area (or volume) within which all decisions must apply (in some cases, this may be defined by the OU). The domain is a region distinctly marked by some physical features (i.e., volume, length, width, and boundary). Figure 4-1 shows the boundaries of the study area. Figure 4-2 is a conceptual illustration of the 100-B/C study area showing the three sampling zones (upland, riparian, and near-shore).

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
1, 2, 3, and 4	The geographic boundary of the investigation is defined in the X-Y dimensions by the boundary shown in Figure 4-1, and in the Z-dimension, from the ground surface, to 4.6 m (15 ft) below grade for the upland area; for the riparian area, the Z-dimension is from the ground surface, to the rooting zone depth, 2 m (6-ft) below ground surface. The riverfront boundary extends into the river to a water depth of 2 m (6 ft). Refer to accompanying discussion and Figure 4-1.

Figure 4-1. 100-B/C Area Pilot Study Geographical Boundary.

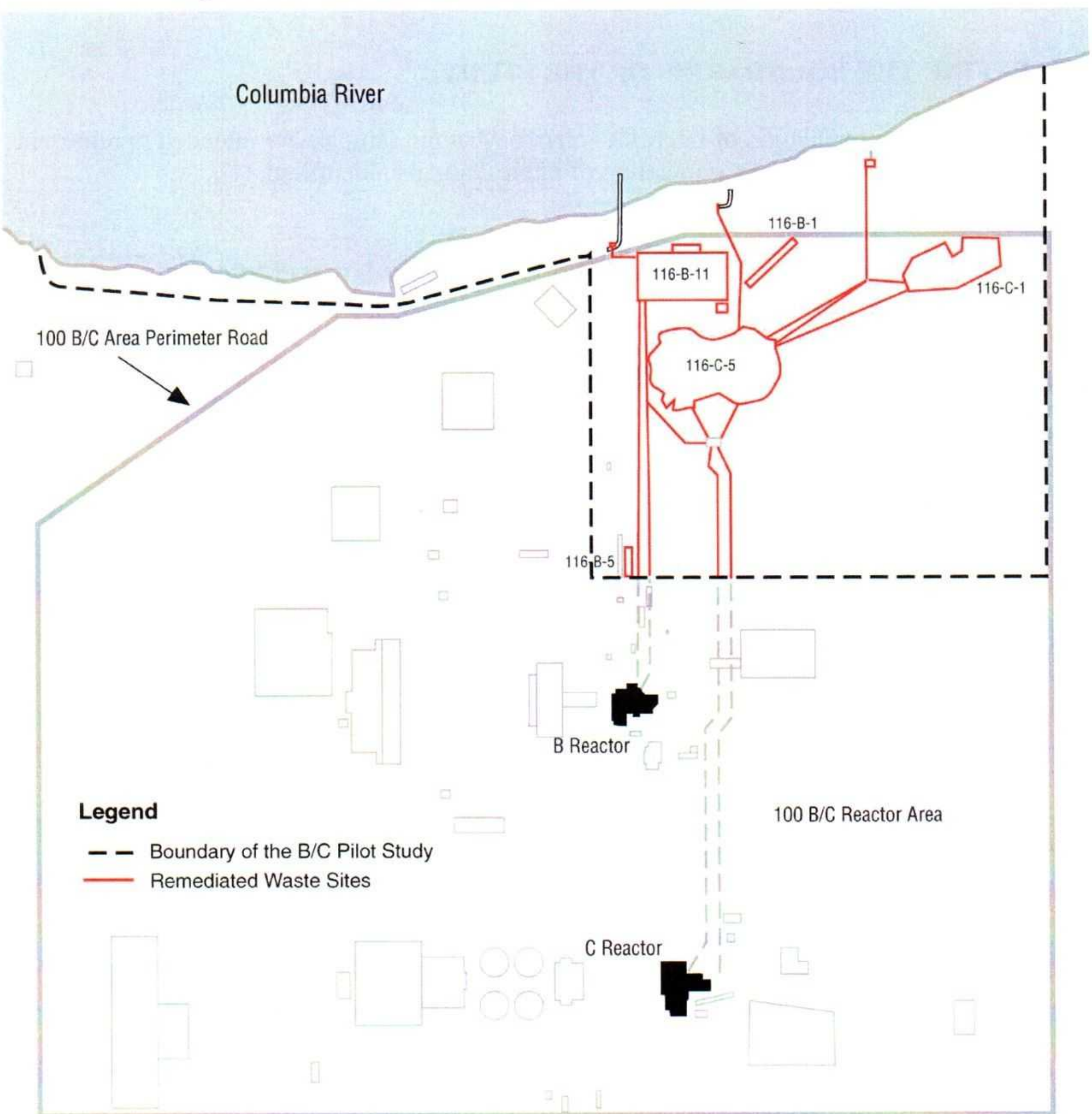
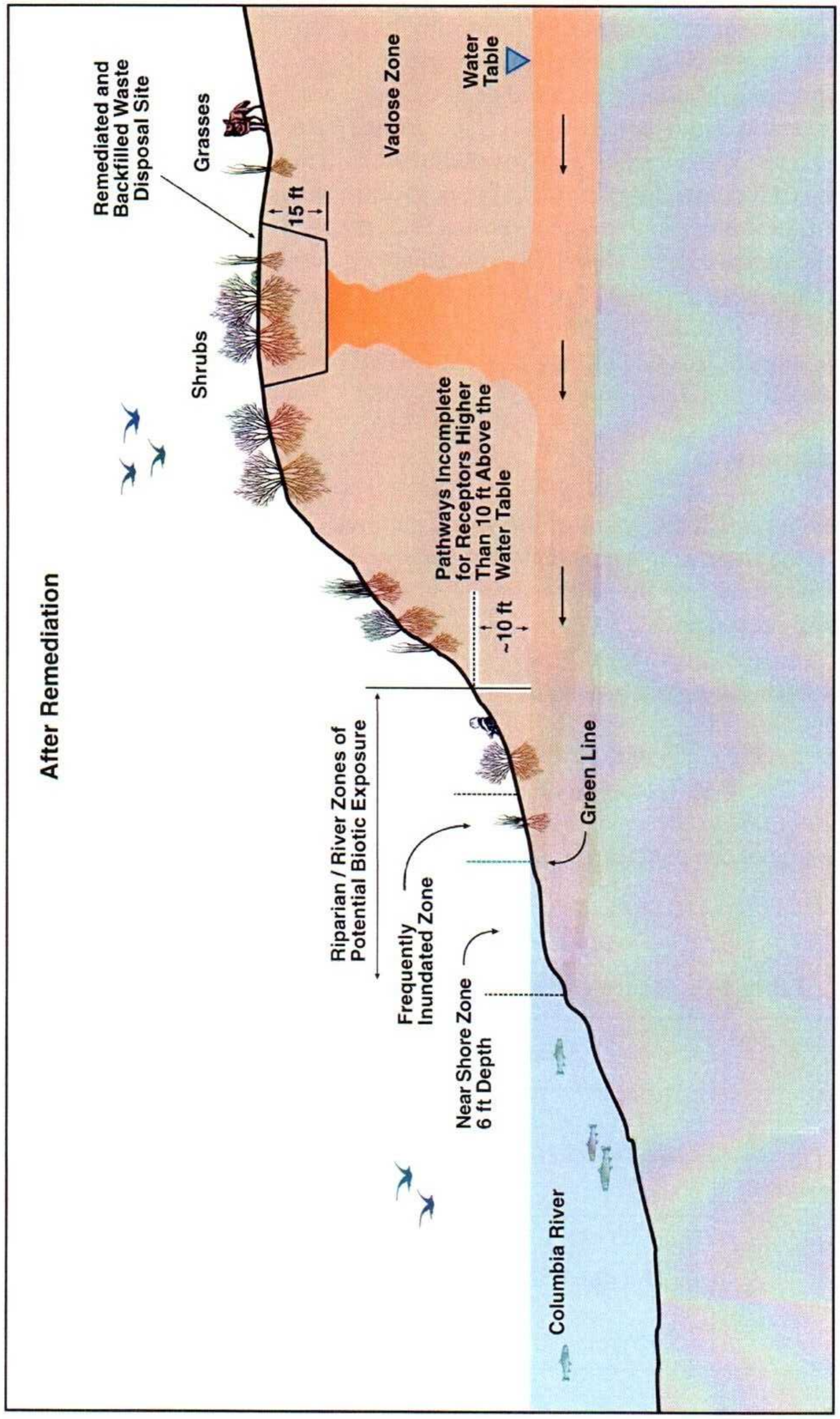


Figure 4-2. 100-B/C Study Area.



4.2.1 Riverfront Boundary Determination

The depth boundary for near-shore riverfront sampling (2 m [6 ft]) is an important value that was determined from empirical data and modeling results. Spatial upwelling patterns of groundwater contaminants in the Columbia River have been calculated using a groundwater river interface flow model (Peterson and Connelly 2001). The groundwater mixing zone in the river is called the hyporheic zone. The dispersal patterns predicted by Peterson and Connelly (2001) suggest that most of the COC upwelling occurs in the near-shore areas and rapidly diminishes, primarily as a function of the water depth of the river due to hydraulic head pressure. Patton et al. (2002) corroborated the model results. Sampling results are consistent with these model results, as all COCs measured in bivalves along the 300 Area in 2001 showed a rapid decline in the COCs between 0- and 2-m (6-ft) river depths. These modeling and biota sampling results have therefore been adopted by this pilot study as the basis for establishing the near-shore river boundary for abiotic and biota sampling of the hyporheic zone.

4.2.2 Groundwater

As noted in Section 1.13, the scope of this DQO summary report is limited to the collection of groundwater at the river/shoreline interface where it becomes available to biotic receptors. However, the data may also be used to support groundwater modeling and/or for remedial action decision-making purposes.

4.2.3 Strata with Homogeneous Characteristics

When appropriate, the study area is divided into strata that have relatively homogeneous characteristics. The DQO team systematically evaluates process knowledge, historical data, and reactor configurations to present evidence of logic that supports alignment of the population into strata with homogeneous characteristics. Table 4-3 identifies the strata with homogeneous characteristics.

Table 4-3. Strata with Homogeneous Characteristics. (5 Pages)

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
1and 2	The set of environmental soil and water samples within the 100-B/C Area	***Upland abiotic***	Zone impacted by remediation and heaviest physical disturbance, which limits the biological community development. Native soils have been removed and are severely disturbed.
		Backfill over remediated waste sites	All soils backfilled into remediated waste sites were associated with the same borrow site. Clean backfill used in accordance with the 100 Area RDR/RAWP (DOE-RL 2002); therefore, characterization is not required.

Table 4-3. Strata with Homogeneous Characteristics. (5 Pages)

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
		Excavation pit sidewalls	Residual contaminated sidewalls of the remediated waste sites. Characterization completed during waste site verification process. Further characterization is not required.
		Excavation pit floor	Residual contaminated pit floor of the remediated waste sites. Characterization completed during waste site verification process. Further characterization is not required.
		Buffer zone	Perimeter area surrounding waste site shallow zone excavation limits. Characterization completed during waste site verification process. Further characterization is not required for human health risk determination. However, this zone does have potential for deep-rooted plants and burrowing animals to contact low levels of residual contamination and should be sampled with biota.
		Areas between and outside of waste sites	Land areas not directly associated with waste sites. Characterization is not required in accordance with global issue #2.
	The set of environmental soil samples located within appropriate reference sites	Upland reference areas	Duplicate upland reference area (TBD) for comparison with 100-B/C Area results.
3 and 4	The set of biota and soil samples within the 100-B/C Area	***Upland biota***	Resident biota observed in the upland buffer zones.
		Vertebrates	Resident vertebrates in the upland buffer zones with potential sampling significance.
		Invertebrates	Resident invertebrates in the upland buffer zones with potential sampling significance.
		Plants	Resident flora in the upland buffer zones with potential sampling significance.
	The set of environmental biota and soil samples located within appropriate reference sites	Upland reference area biota	Duplicate upland biota samples in reference area (TBD) for comparison with 100-B/C Area results.

Table 4-3. Strata with Homogeneous Characteristics. (5 Pages)

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
1 and 2	The set of environmental soil and water samples within the 100-B/C Area	***Riparian abiotic***	Potentially most significant ecological zone.
		Areas outside waste sites	These areas were not contaminated during plant operations and not remediated, except for flume areas.
		Discharge pipelines and outfall spillways	Areas within the riparian zone with potential for residual contamination from reactor operations.
		Frequent river inundation (varial) zone	Transition zone shared by riparian zone and the riverbed. It is alternately exposed to air and wetted with changing river stage.
		Persistent riparian community zone	Area above the frequent river inundation zone that exhibits a stable vegetation community.
	The set of environmental soil and water samples located within appropriate reference sites	Riparian reference areas	Duplicate riparian reference area (TBD) for comparison with 100-B/C Area results.
3 and 4	The set of biota samples within the 100-B/C Area	***Riparian biota***	Resident biota observed in the riparian area.
		Vertebrates	Resident vertebrates in the riparian zone with potential sampling significance.
		Invertebrates	Resident invertebrates in the riparian zone with potential sampling significance.
		Plants	Resident flora in the riparian zone with potential sampling significance.
	The set of environmental biota samples located within appropriate reference sites	Riparian reference area biota	Duplicate riparian biota samples in reference area (TBD) for comparison with 100-B/C Area results.

Table 4-3. Strata with Homogeneous Characteristics. (5 Pages)

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
1 and 2	The set of environmental soil and water samples within the 100-B/C Area	*Near-shore river abiotic*	Potentially sensitive ecological zone (persistent aquatic zone below the 46,300 cfs level).
		Riverbed	The sediments and substrates covered by river water from the shoreline to a water depth of 2 m (6 ft).
		• Substrate #1	Substrate consists of fines, sand, silt, and mud. The substrate category suitable for sampling and analysis due to affinity for contaminant retention.
		• Substrate #2	Substrate consists of gravel to medium cobble. No affinity for contamination adsorption or retention. Substrate category not suitable for sampling and analysis.
		• Substrate #3	Substrate consists of large cobble. No affinity for contamination adsorption or retention. Substrate category not suitable for sampling and analysis.
		• Substrate #4	Substrate consists of boulder/bedrock. No affinity for contamination adsorption or retention. Substrate category not suitable for sampling and analysis.
		Seeps[a]	Seeps are emerging groundwater along the river shoreline. There are three surveyed seeps (SB-037-1, SB-038-3, and SB-039-2) and six intermittent seeps within the 100-B/C Area (3-2, 3-3, 3-4, 041-1, 4-1, and 4-2).
		River shore	River water collected along shoreline to a depth of 2 m (6 ft).
	The set of environmental soil and water samples located within appropriate reference sites	Near-shore river reference areas	Duplicate near-shore river reference areas (TBD) for comparison with 100-B/C Area results.

Table 4-3. Strata with Homogeneous Characteristics. (5 Pages)

DS #	Population of Interest	Strata	Homogeneous Characteristic Logic
3 and 4	The set of biota samples within the 100-B/C Area	***Near-shore river biota***	Near-shore river zone below the 46,300 cfs level.
		Vertebrates	Resident vertebrates in the river with potential sampling significance.
		Invertebrates	Resident invertebrates in the river with potential sampling significance.
		Plants	Resident flora in the river with potential sampling significance.
	The set of environmental biota samples located within appropriate reference sites	Near-shore river reference area biota	Duplicate near-shore river biota samples in reference areas (TBD) for comparison with 100-B/C Area results.

[a] The seeps were categorized under near-shore river to support sampling design development in DQO Step 7. However, it is recognized that the seeps are partially present within the riparian zone.

4.2.4 Upland Abiotic Zone

As noted in Table 4-3, none of the strata within the upland abiotic zone will require characterization to satisfy the human-health risk evaluation (DS #1 or DS #2). These strata (1) contain clean backfill material, (2) were characterized during the 100-B/C Area waste site soil remediation project, or (3) were determined to be outside the scope of this pilot study. Therefore, these strata will not be carried further in this study. However, the buffer zone around the waste sites has potential significance for the biota (DS #3 and DS #4) and will therefore be carried through the DQO process in the tables that follow. The upland reference area will also be carried through this process.

4.2.5 Substrate

The soils on the river bottom are classified into four substrate types as shown in Table 4-3 (under the near-shore river abiotic subhead). These subtier strata hold potential sampling significance because of their habitat relationship with resident biota that could be contaminated by groundwater and seeps emerging along the river shoreline. It is therefore desirable to sample both the biota and substrate upon which, or near which, the biota reside. However, because of their large grain sizes, the category 2, 3, and 4 near-shore river substrates (gravel to boulders/bedrock) do not adsorb or retain the groundwater contaminants emerging into the river and should not be sampled. Conversely, the category 1 substrate (fines, sand, silt, and mud) has an affinity for contamination and will be sampled with the biota whenever present in sufficient quantities.

4.2.6 Flow Bands (River Stage Exceedence Intervals)

The river stage of the Hanford Reach fluctuates daily and seasonally in response to operations at the upstream hydroelectric dams. These fluctuations can at times range over depths of 2 to 3 m (6.6 to 9.8 ft) per day. Because the distribution, abundance, and behavior of the biota inhabiting the near-shore environment are affected by these fluctuations, it is essential to establish a standardized sampling approach to assure that the samples collected from the 100-B/C Area are comparable to those collected from noncontaminated reference sites.

River water fluctuation patterns can be expressed as the percent of time that a given area is inundated by water "exceedence" levels, and water fluctuations can be directly related to total river water discharge rates (cfs "flow bands"). These discharge rates, or flow bands, have been documented since the hydroelectric facilities were built. These flow bands have been analyzed (by the Public Safety and Resource Protection Program [PSRPP]) to describe the river water fluctuation patterns in recent years (1994-2001). As an example, over the 8-year period (1994-2001), water flow bands never exceeded 350,000 cfs, and would be identified as 0% exceedence level (the given area is never inundated by water). And river flows during this period have never been recorded below 35,000 cfs and, thus, reflect the 100% exceedence level (the given area is always inundated by water).

Between the years 1994 and 2001, water fluctuation patterns were analyzed and expressed in terms of flow bands representing the areas inundated at successive increments of the percent of time wetted "exceedence" into ten intervals (i.e., 10% intervals). For example, the coverages show the areas in the Hanford Reach wetted 20% of the time, 30% of the time, 40% of the time, and up to 100% of the time.

Riverine classifications were further stratified by river flow bands that were identified according to the frequency of occurrence of selected biota (Figure 4-3). These flow bands were defined by the occurrence of selected biota sampled along 17 bathymetry transects comprised of 193 sample plots, along a 15-km (9.9-mi) stretch of the Columbia River immediately upstream of the Hanford Site (ongoing research in the PSRPP). The flow bands shown in Figure 4-3 depict the boundaries of the persistent aquatic community, the frequent river inundation zone, and the persistent riparian community.

The persistent aquatic community zone (shown at the far right side of Figure 4-3) is the portion of the aquatic zone that is suitable for sampling near-shore river biota in the 100-B/C Area and in noncontaminated reference areas. The onset of this zone is the "green line," which is a dark-green layer that corresponds to the 46,300 cfs river flow. It is where the periphyton frequency of occurrence shifts from marginal to nearly 100%.

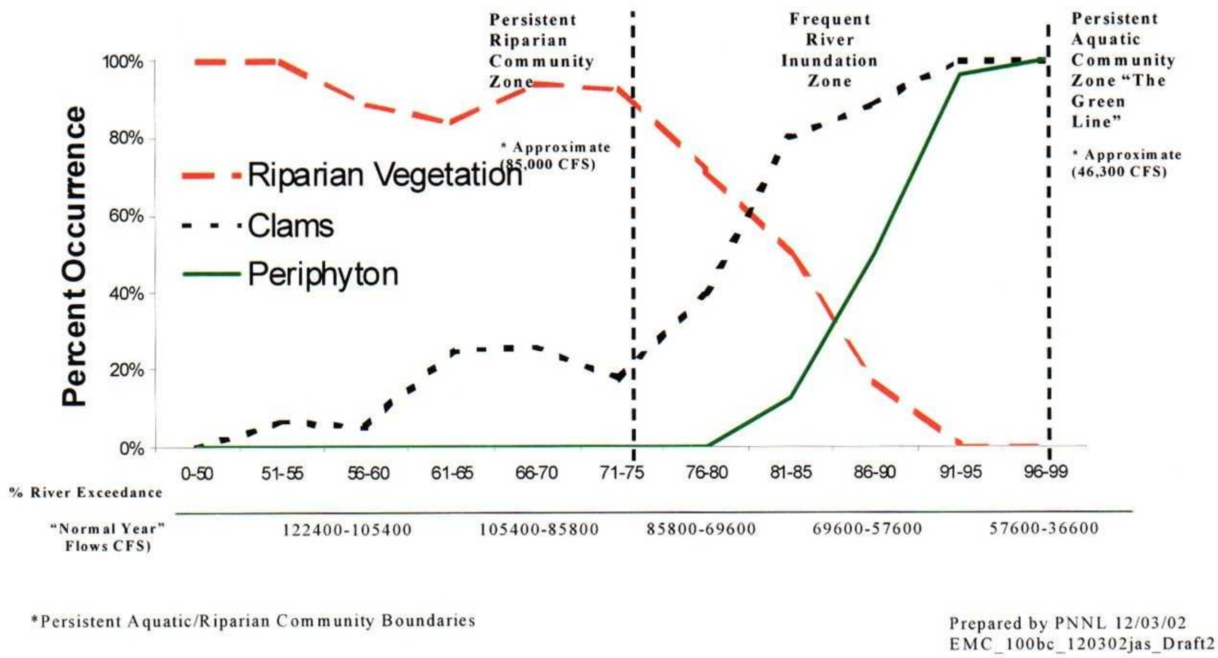
The frequent river inundation zone shown in Figure 4-3 is between the two dashed vertical lines (flow bands). The lower flow band corresponds to the "green line." The steeply sloped curves in this zone indicate that the vegetation and aquatic populations are transitory. The upper bound of this zone, depicted by a dashed vertical line, corresponds to the 85,000 cfs river flow.

The persistent riparian community zone (shown at the far left of Figure 4-3) is the portion of the riparian zone that is generally not affected by river fluctuations and that exhibits a stable vegetation community.

4.2.7 Selection of Reference Areas

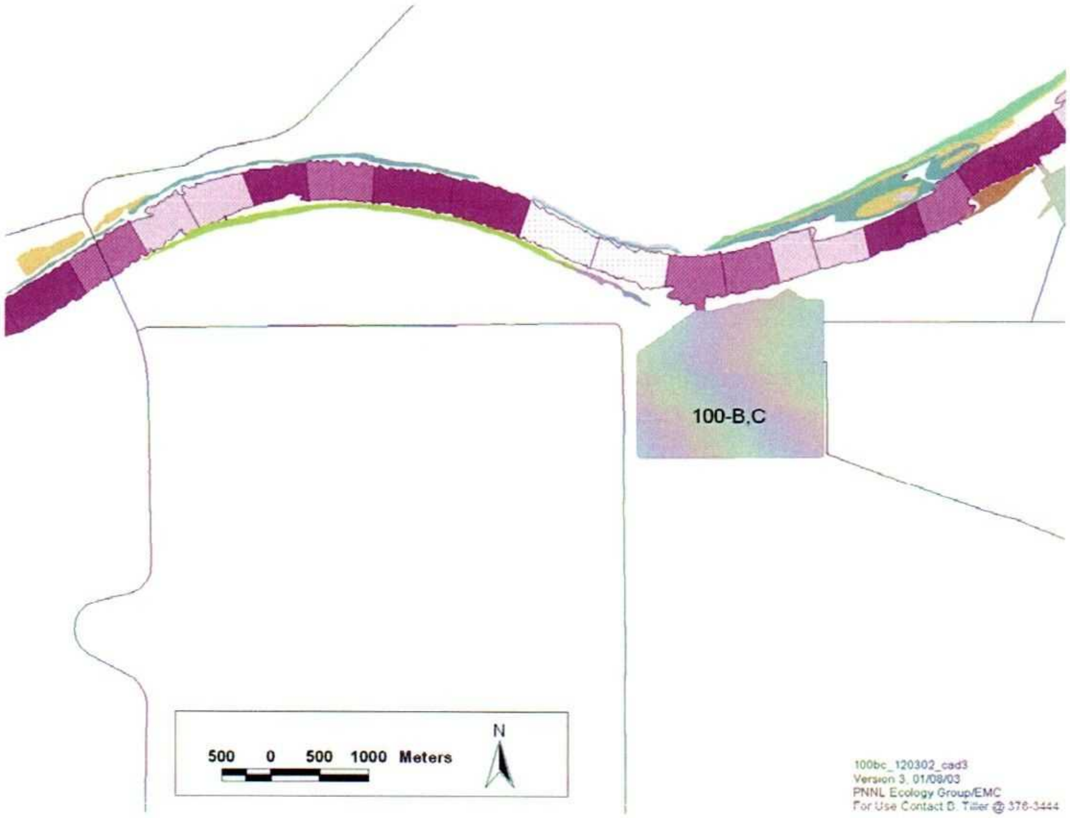
Reference area locations will be selected that most closely match the upland, riparian, and river community study sites in physical characteristics. This allows for a more direct comparison of the presence and abundance of biota, as well as relative comparison of the biological health and contaminant burden of biota collected from both locations.

Figure 4-3. Flow Bands That Depict the Boundaries of the Three Shoreline Zones.



The riparian environment will be stratified (or distinguished) based on the plant community identified as part of the PSRPP geographical information systems-based biota datasets. Distinct classifications will also be made for the river. The river is delineated based on river bottom morphology and backwater sloughs. The four types of river morphology include narrow/ symmetric, wide/symmetric, wide asymmetric, and narrow asymmetric. Figure 4-4 shows the existing riparian plant communities along the shoreline and the riverine classifications by the denoted shaded/segmented areas. These strata provide the basis for selecting reference locations for comparison of biological "health assessment metrics" collected from areas of elevated contamination. Determination of reference locations will be made in the field on the basis of observed substrate conditions and comparisons with the map shown in Figure 4-4.

Figure 4-4. Riparian and River Community Types Based on Geological and Physical Characteristics of the Columbia River Environments Near the 100-B/C Area.



4.2.8 Temporal Boundaries

The temporal boundaries of the decision are defined in Table 4-4.

Table 4-4. Temporal Boundaries of the Investigation. (2 Pages)

DS #	Timeframe	When to Collect Data
1 and 2	Low river stage, likely August through November, depending on degree of snow pack	Sampling of seeps must be performed during low river stages to isolate groundwater from river.
		Radiological surveys and soil sampling at riparian zone discharge pipelines and outfall spillways must be performed during low river stages to enable access and availability of sampling material.

Table 4-4. Temporal Boundaries of the Investigation. (2 Pages)

DS #	Timeframe	When to Collect Data
3 and 4	Seasonal abundance/availability	Upland, riparian biota sampling must be performed during timeframes appropriate for the particular biota being sampled. These details will be defined in the SAP.
1, 2, 3, and 4	TBD	A multi-year sampling approach may be required to collect adequate data to demonstrate adverse impacts to ecological receptors.

4.3 SCALE OF DECISION MAKING

Table 4-5 defines the scale of decision making for each DS. The scale of decision making is defined as the smallest, most appropriate subsets (strata) of the population (subpopulation) for which decisions will be made based on the spatial or temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making. (3 Pages)

<table>
<tr><th rowspan="2">DS #</th><th rowspan="2">Population of Interest</th><th rowspan="2">Geographic Boundary</th><th colspan="2">Temporal Boundary</th><th rowspan="2">Strata</th></tr>
<tr><th>Timeframe</th><th>When to Collect Data</th></tr>
<tr><td rowspan="3">1 and 2</td><td rowspan="2">The set of environmental soil samples within the 100-B/C Area</td><td rowspan="7">The geographic boundary of the investigation is defined in the X-Y dimensions by the boundary shown in Figure 4-1, and in the Z-dimension, from the ground surface, to 4.6 m (15 ft) below grade for the upland area; for the riparian area, the Z-dimension is from the ground surface, to the rooting zone depth, 2 m (6 ft) below ground surface. The riverfront boundary extends into the river to a water depth of 2 m (6 ft).</td><td rowspan="2">--</td><td rowspan="3">--</td><td>Upland abiotic</td></tr>
<tr><td>No buffer zone soil sampling (refer to Section 4.2.4)</td></tr>
<tr><td>The set of environmental soil samples located within appropriate reference sites</td><td>--</td><td>No upland reference area soil sampling</td></tr>
<tr><td rowspan="4">3 and 4</td><td rowspan="4">The set of biota samples within the 100-B/C Area</td><td rowspan="4">Timeframes species-dependent, identified in DQO Step 7</td><td rowspan="4">Species-dependent</td><td>Upland biota</td></tr>
<tr><td>Buffer zone vertebrates</td></tr>
<tr><td>Buffer zone invertebrates</td></tr>
<tr><td>Buffer zone plants</td></tr>
</table>

Table 4-5. Scale of Decision Making. (3 Pages)

DS #	Population of Interest	Geographic Boundary	Temporal Boundary: Timeframe	Temporal Boundary: When to Collect Data	Strata
	The set of environmental biota samples located within appropriate reference sites			Same species as upland biota	Upland reference area biota
1 and 2	The set of environmental soil and water samples within the 100-B/C Area		No temporal constraints on sampling	--	***Riparian abiotic***
					Areas outside waste sites
			August through November	During low river stages for access	Discharge pipelines and outfall spillways
					Frequent river inundation (varial) zone
			TBD during field sampling	TBD	Persistent riparian community zone
	The set of environmental soil and water samples located within appropriate reference sites		Same as 100-B/C Area riparian sampling	Same as 100-B/C Area riparian sampling	Riparian reference areas
3 and 4	The set of biota samples within the 100-B/C Area		Timeframes species-dependent, identified in DQO Step 7	Species-dependent	***Riparian biota***
					Vertebrates
					Invertebrates
					Plants
	The set of environmental biota samples located within appropriate reference sites		Same as 100-B/C Area riparian biota sampling	Same as 100-B/C Area riparian biota sampling	Riparian reference area biota

Table 4-5. Scale of Decision Making. (3 Pages)

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Strata
			Timeframe	When to Collect Data	
1 and 2	The set of environmental soil and water samples within the 100-B/C Area		No temporal constraints on sampling	--	*Near-Shore River Abiotic*
					Riverbed[a]
					Substrate #1
		The geographic boundary of the investigation is defined in the X-Y dimensions by the boundary shown in Figure 4-1, and in the Z-dimension, from the ground surface, to 4.6 m (15 ft) below grade for the upland area; for the riparian area, the Z-dimension is from the ground surface, to the rooting zone depth, 2 m (6 ft) below ground surface. The riverfront boundary extends into the river to a water depth of 2 m (6 ft).	August through November	Low river stage	Seep groundwater
			No constraints	--	River shore
	The set of environmental soil and water samples located within appropriate reference sites		Same as 100-B/C Area near-shore river sampling	Same as 100-B/C Area near-shore river sampling	Near-shore river reference areas
3 and 4	The set of biota samples within the 100-B/C Area		Timeframes species-dependent identified in DQO Step 7	Species dependent	*Near-shore river biota*
					Vertebrates
					Invertebrates
					Plants
	The set of environmental biota samples located within appropriate reference sites		Same as 100-B/C Area near-shore river biota sampling	Same as 100-B/C Area near-shore river biota sampling	Near-shore river reference areas

[a] Substrates 2, 3, and 4 were dropped from sampling consideration in accordance with Table 4-3 and the substrate discussion in Section 4.2.

4.4 PRACTICAL CONSTRAINTS

Table 4-6 identifies the practical constraints that may impact the data collection effort. These constraints include physical barriers, difficult sample matrices, high radiation areas, or any other condition that will need to be considered for the design and scheduling of the sampling program.

Table 4-6. Practical Constraints on Data Collection.

The physical disturbance of the soil environment is widespread within the 100-B/C Area. This has limited the biological community development and could also limit biota populations available for ecological sampling.
Low river stages are necessary for collection of groundwater from seeps, discharge pipeline trenches, outfall spillways, and the inundation zone.
Sampling windows will be limited by seasonal availability of biota (see DQO Step 7 for more information).
Extreme weather conditions may limit or shut down field sampling operations.
High or low river flows may affect the abundance and availability of aquatic biota and sampling in the inundation zone.
Biological sampling presents some limitations generally not associated with abiotic sampling. The amount of material available for biological sampling may be limited by the lack of or size of the desired organisms. Certain of the analyses require relatively large sample volumes. Inadequate sample volumes may result in degraded detection limits. This may at times be overcome by compositing to increase the mass of the sampled media. Decisions will be made on a case-by-case basis based on professional judgment.
Analyses of biota samples will not include semi-volatile or volatile organic constituents unless they are detected in the soil or water samples.

5.0 STEP 5 – DEVELOP A DECISION RULE

The purpose of DQO Step 5 is initially to define the statistical parameter of interest (i.e., maximum, mean, or 95% UCL of the mean) that will be used for comparison to the action level. The statistical parameter of interest specifies the characteristic or attribute that a decision maker would like to know about the population. The preliminary action level for each of the COCs is also identified in DQO Step 5. When this is established, a decision rule (DR) is developed for each DS in the form of an "IF…THEN…" statement that incorporates the parameter of interest, the scale of decision making, the preliminary action level, and the AAs that would result from resolution of the decision.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1, 5-2, and 5-3 present the information needed to formulate the DRs that are presented in Section 5.2. This information includes the DSs and AAs identified in DQO Step 2, the scale of decision making identified in DQO Step 4, and the statistical parameters of interest and preliminary action levels for each of the COCs.

Table 5-1. Decision Statements.

DS #	*Decision Statement*
1	Determine if the residual soil is radiologically contaminated and remove additional contaminated soil, provide institutional controls to prevent access to contaminated soils, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.
2	Determine if the residual soil is chemically contaminated and remove additional contaminated soil, provide institutional controls to prevent access to contaminated soils, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.
3	Determine if the biota are radiologically contaminated, and perform additional soil remediation, implement bio-barriers, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.
4	Determine if the biota are chemically contaminated, and perform additional soil remediation, implement bio-barriers, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.

Table 5-2. Inputs Needed to Develop 100 Area Decision Rules. (2 Pages)

DS #	COCs	Statistical Parameter of Interest	Decision Units[a]	Action Levels	Alternative Actions
1	Radiological COCs	95% UCL of the mean, average, or maximum detected value, as appropriate	***Upland abiotic*** – No decision units ***Riparian abiotic*** Areas outside waste sites Discharge pipelines and outfall spillways Frequent river inundation zone Persistent riparian community zone ***Near-shore river abiotic*** Riverbed • Substrate #1 Seep groundwater River shore	***Human health*** – direct radiological exposure dose rate limit of 15 mrem/yr above background. Groundwater[b] radiological exposure dose rate limit of 4 mrem/yr above background, based on site contaminant distribution model and RESRAD modeling, or leach rate testing. ***Ecological protection*** – Table 1-7 BCG values.	Remove radiologically contaminated soil, provide institutional controls to prevent access, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.
2	Chemical COCs	95% UCL of the mean[c], maximum detected values, or detected value, as appropriate	***Riparian abiotic*** Areas outside waste sites Discharge pipelines and outfall spillways Frequent river inundation zone Persistent riparian community zone ***Near-shore river abiotic*** Riverbed • Substrate #1 Seep groundwater River shore	***Human health*** – Table 1-8 human health values; or the site contaminant distribution model and RESRAD modeling, or leach rate testing relative to drinking water or surface water criteria; and cumulative risk not to exceed 10^{-5}. ***Ecological protection*** – Table 1-8 ecological screening values.	Remove chemically contaminated soil, provide institutional controls to prevent access to contaminated soils, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.

Table 5-2. Inputs Needed to Develop 100 Area Decision Rules. (2 Pages)

DS #	COCs	Statistical Parameter of Interest	Decision Units[a]	Action Levels	Alternative Actions
3	Radiological COCs	95% UCL of the mean, average, or maximum detected value, as appropriate	***Upland biota***	Contaminants in the 100-B/C Area biota tissue samples exceed tissue concentrations from the noncontaminated reference areas, and unfavorable evaluation results from the weight of evidence determination.	Perform additional soil remediation, construct bio-barriers, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.
			Vertebrates in buffer zone		
			Invertebrates in buffer zone		
			Plants in buffer zone		
			Riparian biota		
			Vertebrates		
			Invertebrates		
			Plants		
			Near-shore river biota		
			Vertebrates		
			Invertebrates		
			Plants		
4	Chemical COCs	95% UCL of the mean, average, or maximum detected value, as appropriate	***Upland biota***	Contaminants in the 100-B/C Area biota tissue samples exceed tissue concentrations from the noncontaminated reference areas, and unfavorable evaluation results from the weight of evidence determination.	Perform additional soil remediation, construct bio-barriers, perform additional investigation, or monitor conditions in the 100-B/C Area until land transfer.
			Vertebrates in buffer zone		
			Invertebrates in buffer zone		
			Plants in buffer zone		
			Riparian biota		
			Vertebrates		
			Invertebrates		
			Plants		
			Near-shore river biota		
			Vertebrates		
			Invertebrates		
			Plants		

[a] Reference areas are listed in Tables 4-3 and 4-5 as strata; however, they are not included in this table because they are not decision units. Decision units are the geographic locations in which the decisions apply. Data obtained from reference areas will be used to support decision making in the decision units, not the reference areas.

[b] The groundwater portion of the radiological criteria uniquely applies to the rural-residential exposure scenario.

[c] Satisfaction of MTCA criteria requires a three-part test. However, Ecology considers the 95% UCL as the statistical parameter of interest. The maximum and detected values support hot spot evaluations, which are a necessary aspect of site closeout under MTCA.

The alternative actions identified in DQO Step 2 are summarized in Table 5-3.

Table 5-3. Alternative Actions.

PSQ #	AA #	Alternative Actions
1	1	Remove radiologically contaminated soil.
	2	Provide institutional controls to prevent access to contaminated soils.
	3	Perform additional investigation
	4	Monitor conditions in the 100-B/C Area until land transfer.
2	1	Remove chemically contaminated soil.
	2	Provide institutional controls to prevent access to contaminated soils.
	3	Perform additional investigation
	4	Monitor conditions in the 100-B/C Area until land transfer.
3	1	Perform additional soil remediation.
	2	Construct bio-barriers.
	3	Perform additional investigation
	4	Monitor conditions in the 100-B/C Area until land transfer.
4	1	Perform additional soil remediation.
	2	Construct bio-barriers.
	3	Perform additional investigation
	4	Monitor conditions in the 100-B/C Area until land transfer.

5.2 DECISION RULES

The output of DQO Step 5 and the previous DQO steps are combined into "IF...THEN" DRs that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision. The DRs are listed in Table 5-4.

Table 5-4. Decision Rules.

DR #		Decision Rule
1	a	If the mean activity (as estimated by the 95% UCL on sample mean, average, or maximum detected value, as appropriate) of radionuclides within the soil samples in each of the applicable strata[a] results in a direct human health radiological exposure dose greater than or equal to 15 mrem/yr above background, or a groundwater[b] radiological dose greater than or equal to 4 mrem/yr above background (based on the site contaminant distribution model and RESRAD modeling, or leach rate testing), then remove radiologically contaminated soil, provide institutional controls to prevent access to contaminated soils, or perform additional investigation. Otherwise, monitor conditions in the 100-B/C Area until land transfer.
	b	If the mean activity (as estimated by the 95% UCL on sample mean, average, or maximum detected value, as appropriate) of radionuclides within the soil samples in each of the applicable strata[a] results in a direct radiological exposure greater than or equal to that represented by the ecological BCG values in Table 1-7, then remove radiologically contaminated soil, provide institutional controls to prevent access to contaminated soils, or perform additional investigation. Otherwise, monitor conditions in the 100-B/C Area until land transfer.
2	a	If the mean concentrations (as estimated by the 95% UCL on sample mean, average, or maximum detected value, as appropriate) of chemical constituents within the soil samples in each of the applicable strata[a] is greater than or equal to the human health values in Table 1-8, or values determined from the site contaminant distribution model and RESRAD modeling, or leach rate testing exceed drinking water or surface water criteria, or if the cumulative risk value for all detected constituents exceeds cumulative risk criteria (10^{-5}), then remove chemically contaminated soil, provide institutional controls to prevent access to contaminated soils, or perform additional investigation. Otherwise monitor conditions in the 100-B/C Area until land transfer.
	b	If the mean concentrations (as estimated by the 95% UCL on sample mean, average, or maximum detected value, as appropriate) of chemical constituents within the soil samples in each of the applicable strata[a] is greater than or equal to the limiting of the ecological screening values in Table 1-8, then remove chemically contaminated soil, provide institutional controls to prevent access to contaminated soils, or perform additional investigation. Otherwise monitor conditions in the 100-B/C Area until land transfer.
3		If the mean activity (as estimated by the 95% UCL on sample mean, average, or maximum detected value, as appropriate) of radionuclides within the tissue samples from each of the applicable biota[c] exceed the respective biota tissue samples from noncontaminated reference areas and unfavorable evaluation results from the of weight of evidence determination, then perform additional soil remediation, construct bio-barriers, or perform additional investigation. Otherwise monitor conditions in the 100-B/C Area until land transfer.
4		If the mean concentrations (as estimated by the 95% UCL on sample mean, average, or maximum detected value, as appropriate) of chemical constituents within the tissue samples from each of the applicable biota[c] exceed the respective biota tissue samples from non-contaminated reference areas and unfavorable evaluation results from the of weight of evidence determination, then perform additional soil remediation, construct bio-barriers, or perform additional investigation. Otherwise monitor conditions in the 100-B/C Area until land transfer.

[a] The applicable strata are the decision units identified in Table 5-2.
[b] The groundwater portion of the radiological criteria uniquely applies to the rural-residential exposure scenario.
[c] Specific biota selected for sampling are identified in DQO Step 7.

6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data can only estimate the true condition of the site under investigation, decisions that are made based on measurement data could potentially be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which DSs (if any) require a statistically based sample design. For those DSs requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error.

6.1 STATISTICAL VERSUS NON-STATISTICAL SAMPLING DESIGN

Table 6-1 provides a summary of the information used to support the selection between a statistical versus a judgmental sampling design for each DS. The factors that were taken into consideration to make this selection were determined in DQO Step 2 and included the qualitative consequences of an inadequate sampling design and the accessibility of the site if resampling is required. For decisions that carry severe consequences of erroneous alternative actions and for which the sampled media is not accessible for resampling after remediation, statistical sampling designs are normally employed. When the consequences of erroneous alternative actions are moderate or low, and when resampling may be performed after remediation, judgmental sampling may be considered.

Table 6-1. Justification for Sampling Design. (2 Pages)

DS #	PSQ Summary	Alternative Action Summary		Consequence Severity	Resampling Access After Remediation	Preliminary Step 6 Sample Design Basis
1	Is the soil radiologically contaminated?	1	Remove radiologically contaminated soil.	Low	Accessible	Judgmental sampling
		2	Provide institutional controls to prevent access to contaminated soils.	Low	Accessible	
		3	Perform additional investigation	Moderate	Accessible	
		4	Monitor conditions in the 100-B/C Area until land transfer.	Moderate	Accessible	
2	Is the soil chemically contaminated?	1	Remove chemically contaminated soil.	Low	Accessible	Judgmental sampling
		2	Provide institutional controls to prevent access to contaminated soils.	Low	Accessible	

Table 6-1. Justification for Sampling Design. (2 Pages)

DS #	PSQ Summary	Alternative Action Summary		Consequence Severity	Resampling Access After Remediation	Preliminary Step 6 Sample Design Basis
2	Is the soil chemically contaminated?	3	Perform additional investigation.	Moderate	Accessible	Judgmental sampling
		4	Monitor conditions in the 100-B/C Area until land transfer.	Moderate	Accessible	
3	Are biota in the 100-B/C Area radiologically contaminated?	1	Perform additional soil remediation.	Low	Accessible	Judgmental sampling
		2	Implement bio-barriers.	Moderate	Accessible	
		3	Perform additional investigation.	Moderate	Accessible	
		4	Monitor conditions in the 100-B/C Area until land transfer.	Moderate	Accessible	
4	Are biota in the 100-B/C Area chemically contaminated?	1	Perform additional soil remediation.	Low	Accessible	Judgmental sampling
		2	Implement bio-barriers.	Moderate	Accessible	
		3	Perform additional investigation.	Moderate	Accessible	
		4	Monitor conditions in the 100-B/C Area until land transfer.	Moderate	Accessible	

Table 6-1 indicates that non-statistical, judgmental sampling designs are proposed for this DQO process because of the low and moderate consequences of inadequate sampling designs. This assessment is based on an application of the DQO process with consideration of the status of the 100-B/C Area waste sites, which have been remediated by removal of contaminated soils and engineered structures. Through the CVP process, the residual contamination status of these sites has been well documented, meeting the site closeout criteria for radiological and chemical contamination. The great majority of the contaminated material in the 100-B/C Area has been removed from the waste sites and disposed in the Environmental Restoration Disposal Facility. Therefore, the potential risks associated with erroneous actions at these remediated waste sites are considered to be low to moderate.

In addition, ecological sampling activities have inherent sampling limitations, such as abundance and availability of biota (as noted in Table 4-6) that generally do not support the use of statistical sampling designs.

6.2 NON-STATISTICAL DESIGNS

Systematic grid and biased sampling designs are used in this DQO summary report. Each of the sampling designs is applied according to the type and nature of the media being sampled. The sampling design presentation in DQO Step 7 discusses the salient points of the selected sampling designs.

Because the DSs are resolved using a non-statistical design, there is no need to define the "gray region" or the tolerable limits on decision error because these only apply to statistical designs.

7.0 STEP 7 – OPTIMIZE THE DESIGN

7.1 PURPOSE

The purpose of DQO Step 7 is to identify the most resource-effective design for generating data to support decisions while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed:

- Review the DQO outputs from the previous DQO steps and the existing environmental data.
- Develop general data collection design alternatives.
- Select the sampling design (e.g., techniques, locations, or numbers/volumes) that most cost effectively satisfies the project's goals.
- Document the operational details and theoretical assumptions of the selected design.

7.2 OPTIMIZE THE DESIGN

Table 7-1 identifies information relative to determining the data collection design.

Table 7-1. Determine Data Collection Design.

DS #	Design	Rationale
1, 2, 3, and 4	Judgmental sampling design	The highest levels of contamination are expected to exist in the waste site buffer zones for upland areas; near discharge points, flumes, and seeps in the riparian area; and adjacent to the seeps in the near-shore areas. Because the large waste sites that contained the majority of the contamination inventory have been remediated, the residual contaminant concentrations are expected to be very low, therefore consequences of erroneous decisions are not severe. A judgmental and opportunistic data collection design is appropriate to the investigation because of the limited sample availability (small populations, limited habitat, etc.)

Table 7-2 is used to develop general data collection design alternatives. If the data collection design for a given decision will be non-statistical, determine what type of non-statistical design is appropriate (i.e., haphazard or judgmental).

Table 7-2. Determine Non-Statistical Sampling Design.

DR #	Haphazard	Judgmental
1, 2, 3, and 4	N/A	Professional judgmental sampling design is indicated.

The sample collection design alternatives for this project are described in Table 7-3.

Table 7-3. Methods for Survey/Sample Collection.

Survey/Sampling Media	Description
Soils	Direct reading radiological survey detectors for alpha, beta, and gamma detection.
	A soil surface sampler (1-in. corer) is used to collect surface samples to a depth of 2.54 cm (1 in.) (PNNL [2000b], Section 5.1). Collect rooting zone samples by a soil corer or hand shovels.
Sediment	Grab samples (Patton et al. 2002, Section 3.5).
Periphyton	Plastic scraper (Patton et al. 2002, Section 3.6).
Surface water	Conductivity measurement (PNNL [2000b], Section 4.0; Patton et al. 2002, Section 3.4).
Groundwater	Drive points (Patton et al. 2002, Section 3.4.4).
Plants	Stainless steel snipping shears, by species at each sample site (PNNL [2000b], Section 5.2; Patton et al. 2002, Section 3.6).
Invertebrates/amphibians	Pit fall traps along transect within each sample site, hand-pick bivalves and crayfish (presently in draft form).
Small mammals	Live traps systematically placed along transects within each sample site (PNNL [2000b], Section 7.1; Patton et al. 2002, Section 3.6).
Fish	Backpack electrofisher (PNNL [2000b], Section 7.1; Patton et al. 2002, Section 3.6).

These sample collection options are evaluated based on cost and ability to meet the DQO constraints. These options are integrated in a sampling design leading to the development of a design that meets the DQO constraints. The key features of the selected design are then documented, including (for example) the following:

- Descriptions of sample locations, strata, inaccessible areas, and maps (if beneficial)
- Directions for selecting sample locations (if the selection is not necessary or appropriate at this time)
- Order in which samples should be collected (if important)

- Stopping rules
- Special sample collection methods
- Special analytical methods.

7.3 SAMPLING DESIGN

The 100-B/C pilot study includes diverse geographical areas and sampling media (upland terrestrial soil and biota, riparian terrestrial soil and biota, river shoreline soil, riverbed soils, biota, as well as groundwater and river water). A variety of sampling methods are required to assure that the proper characterization data are collected from these diverse areas and media. The sampling methods considered for the 100-B/C pilot study include:

- **Systematic grid sampling and surveys** – Systematic grid sampling (and surveys) is based on a specified pattern with samples taken at regular intervals along that defined pattern. This method is used to assure that the target population is fully and uniformly represented in the sample. The regular assignment of locations to the sample provides assurance that the sample truly represents the overall characteristics of the target population. To make systematic sampling a probability-based design, the initial location for the first sample of size n is chosen at random; then the remaining (n-1) units are chosen so all n are located according the pattern.

  Samples may be selected in one, two, or three dimensions if the population characteristic of interest has a spatial component. Sampling along a line or transect represents sampling in one dimension. Sampling every node on a grid laid over an area of interest is sampling in two dimensions.

- **Stratified sampling** – Stratified sampling is a sampling design in which prior information about the population is used to determine groups (called strata) that are sampled independently. Each possible sampling population member must belong to exactly one stratum. A stratified sampling design can also be used to obtain estimates for desired subpopulations or to assure that important sub-populations have a sufficient number of sampling units in the samples. One of the most common uses of stratification is to account for spatial variability by defining geographic strata. Sampling by spatial strata may also be useful when study results need to be reported separately for particular geographic areas or regions.

- **Combination of systematic grid and stratified sampling** – Combinations of sampling designs may be used to suit particular needs. The systematic grid sampling design is well suited for combination with the stratified sampling method to provide uniform sampling in a geographic location (grids or transects) for stratified sampling.

The sample design objectives, methods, features and bases are presented in Table 7-4 and are discussed in Section 7.3.1.

7.3.1 Sampling Design Discussion

1. Reconnaissance surveys

   Reconnaissance surveys will be performed as an initial field activity in the upland, riparian, and aquatic areas to determine abundance and availability of sampling populations and sampling locations, and to refine the sampling design. It will be based on visual observations and include both abiotic and biotic sampling populations and will result in the creation of field maps.

2. Systematic grid sampling and surveys

   Gridded radiological surveys – Radiological mapping surveys performed over the riparian and river shoreline are in situ radiological measurements obtained in a continuous (i.e., scanning) or static mode concurrent with a geographic survey (global positioning system or laser-assisted ranging system) to produce a spatial (x, y, and z) map of the radiological measurement data. Alpha, beta, and/or gamma measurements can be made using state-of-the-art radiation detectors coupled to a radiation energy analyzer and a portable computer with commercially available software. Both surveys will be designed to provide at least 20% areal coverage.

   Systematic grid soil sampling – Riparian soil sampling will coincide with the riparian plant receptor sampling. To assure that sampling is well distributed throughout the riparian zone, a randomly started systematic grid will be applied to the area. This systematic grid will also be used to establish the number of samples being collected. Because the resident vegetation will determine sampling locations, the systematic grid design will default to opportunistic sampling to adapt to plant abundance and availability. Soil samples will be collected from the ground surface, to the rooting zones of the plants being sampled based on professional judgment. Selected depth intervals may be chosen from the coincident soil samples to determine contaminant distribution from the ground surface to the rooting depth.

3. Stratified sampling

   Stratified sampling is planned for all biota and reference area biota sampling (upland, riparian, and near-shore riverine). Stratification of biota is the identification and selection of the appropriate resident species in the 100-B/C Area. The identification and selection process was the result of compiling existing ecological studies performed in shoreline areas along the Columbia River and specifically the 100-B/C Area shoreline. In addition, reconnaissance surveys were conducted to inventory the habitats present in the designated sampling areas to get an indication of what species would be available to sample.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Upland, Riparian, Near-Shore River Areas				
Reconnaissance surveys	Determine locations, abundance and availability of sampling populations.	Abiotic and biotic sampling populations	Review existing information and maps. Site visits for visual observations and mapping reconnaissance.	Initial activity for refinement of the sampling design.
Upland Abiotic				
Radiological surveys	Area-wide surveys for site closeout.	Excavated waste sites	N/A – Rely on existing data.	Scope of the pilot study in the upland area is limited to the waste sites being remediated. Therefore, radiological surveys and soil sampling are not necessary because they were performed during waste site verification process. Clean backfill material in remediated waste sites was chosen in accordance with the 100 Area RDR/RAWP and does not need characterization. CVP soil sampling is complete for all but MTCA WAC 173-340-900, Table 749-3-unique COCs, which may be analyzed in 100-B/C Area pipeline CVPs.
Soil sampling	Cleanup verification sampling for site closeout.	Excavated waste sites	N/A – Rely on existing data.	
	Coincident soil sampling to root zone.	Excavated waste site buffer zone	See upland biota sampling.	

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Upland Biota (Buffer Zone Sampling)				
Biota sampling	Determine radioactive and chemical exposure to species, provide screening-level assessment of biota health.	Deer mouse/house mouse (vertebrate)	Stratified sampling for resident species in the upland buffer zone. Number of samples to meet analytical mass requirements and/or statistical data needs. Sampling based on availability of biota. Captures biological health metrics based on screening-level assessments.	Deer/house mouse represents closest fit to mammalian predator guild, satisfies sentinel organism criteria. Collect vertebrates influenced by waste site. Samples will be analyzed for Table 1-9 and Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2.
		Darkling beetles, harvester ants, spiders (invertebrates)		Ground-dwelling invertebrate/soil biota guild satisfies sentinel organism criteria. Samples will be analyzed for Table 1-9 contaminants and as appropriate, biological health metrics in accordance with Table 3-2.
		Tumbleweed, cheatgrass, shrubs, forbs (shallow and deep-rooted plants) and coincident soil sampling	Opportunistic biota sampling in buffer zone based on abundance and availability of plant populations. Collect soil samples at locations coincident with biota samples from ground surface to rooting depth (maximum of 2 m [6 ft]). Soil samples will be archived for possible later use. Sample in spring/early summer for plant maturity.	Plant guild, deep-rooted vegetation, satisfies sentinel organism criteria. Samples will be analyzed for Table 1-9 and Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2. Roots and vegetation (deep and shallow rooted) will be analyzed for specific exposure scenarios (ecological and human risk). Soil samples may be used to determine contaminant distribution.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Upland Reference Area Biota				
Biota sampling	Duplicate upland biota sampling in reference area (to be identified) for comparison with the 100-B/C Area.	Same as upland biota	Same as upland biota (includes coincident soil samples).	Same as upland biota.
Riparian Biota				
Biota sampling	Determine radioactive and chemical exposure to species; provide screening-level assessment of biota health.	Deer mouse/house mouse (vertebrates)	Stratified sampling for resident species in the riparian zone. Systematic grid to determine sampling locations. Default to opportunistic sampling based on availability and abundance of biota using professional judgment. Number of samples to meet analytical mass requirements and/or statistical data needs. Captures biological health metrics based on screening-level assessments. Sampling timeframes based on availability.	Deer/house mouse represents closest fit to mammalian predator guild, satisfies sentinel organism criteria, reference material available. Samples will be analyzed for Table 1-9 and Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2.
		Darkling beetle, harvester ants, spiders (invertebrates)		Ground-dwelling invertebrate/soil biota guild. Satisfies sentinel organism criteria. Samples will be analyzed for Table 1-9 and Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Biota sampling	Determine radioactive and chemical exposure to species; provide screening-level assessment of biota health.	Mulberry, willow trees (plants) Wormwood, sweetclover shrubs (plants) Reed canary grass, cheatgrass (plants)	Stratified sampling for resident species in the riparian zone. Systematic grid to determine sampling locations. Default to opportunistic sampling based on availability and abundance of biota using professional judgment. Number of samples to meet analytical mass requirements and/or statistical data needs. Captures biological health metrics based on screening-level assessments. Sample from spring through fall to allow a full growing season (COC accumulation).	Plant guild, deep/shallow rooted exposure pathway; satisfies sentinel organism criteria, primary producer plant pathways. Samples will be analyzed for Table 1-9 and Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2. Roots and vegetation (deep and shallow rooted) will be analyzed for specific exposure scenarios (ecological and human risk).
Riparian Abiotic				
Radiological surveys	Area-wide surveys.	Riparian surface soils to a depth of 45.7 cm (18 in.)	Reconnaissance of existing radiological surveys and thermoluminescent dosimetry measurements. Systematic grid radiological surveys along transect lines.	Provides minimum of 20% areal coverage for gamma emitting radionuclides to 15 mrem/yr above background (input to human health exposure scenarios from shoreline uses).
	Potentially contaminated areas.	Discharge pipeline and outfall spillways soils, cobbles, concrete surfaces		Establish transect lines over these potentially contaminated features and survey transect lines.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection *Methodology*	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Soil sampling	Characterization sampling	Riparian soils coincident with plant receptors, from surface to rooting depth (maximum of 2 m [6 ft]	Sampling coincident with riparian biota samples. Soil sample depths based on professional judgment.	Determine COC concentrations in areas not contaminated and not remediated. Desired rooting depth based on river stage at low flow "green line." Analyze samples for Table 1-9 contaminants. Soil samples determine contaminant distribution.
	Potentially contaminated areas.	Discharge pipeline and outfall spillways soils, rip-rap, concrete surfaces	Stratified sampling along transects. Collect four samples of soils (where available) along transects at each pipeline/spillway site. Collect samples from sediments and soils between rocks in rip-rap zones. Collect surface samples from concrete spillways.	Sample media may be difficult to locate in these areas because of the presence of interfering materials. If sampling conditions are poor, best available samples will be collected. Sampling may be directed by indications of radiological hotspots during radiological surveys. Concrete samples collected by drilling "*n*" number of co-located holes to a depth of 0.6 cm (0.25 in.) to meet sampling mass requirements. Samples will be analyzed for Table 1-9 and Table 1-10 contaminants.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Riparian Reference Area Biota				
Biota sampling	Duplicate riparian biota sampling in reference area (to be identified) for comparison with 100-B/C study area.	Same as riparian biota	Same as riparian biota (includes coincident soil sampling).	Same as riparian biota.
Near-Shore River Abiotic				
River water conductivity survey	Determine where GW is upwelling to identify primary and secondary seep transect locations as a means of directing abiotic and biotic sampling activities.	River water at sediment/water interface	Step 1 – Reconnaissance (review) of existing seeps, groundwater plume maps, aquifer tube locations, and outfall/pipe discharge information, as well as upstream and downstream reference locations.	Primary transects aligned with existing riverbank seeps, outfall structures (rip-rap covered overflow structures and buried pipelines), and point conductivity measurements to sample groundwater where it emerges into the river. Reference locations selected to match general substrate or habitat types.
			Step 2 – Mapping of potential upwelling by field measurements of conductivity at sediment/water interface. Mapping includes systematic grid sampling using GPS positioning.	Systematic grids along the shoreline, and along and adjacent to seep transect lines into the river. This provides the basis for tracking emergence of seeps into the river. GPS provides accurate position indication.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
River water conductivity survey (Step 2 continued)	Determine where the groundwater is upwelling to identify primary and secondary seep transect locations as a means of directing abiotic and biotic sampling activities.	River water at sediment/water interface	Collect river water conductivity measurements along transects from the shoreline, to a depth of 2 m (6.6 ft). Potential locations include: Upstream reference transect (TBD); as many as 6 primary transects in the study area, and a down stream transect (TBD). Up to six sampling points will be identified for each primary transect (starting at the "green line") and extending towards the main channel, e.g., sample points may be located at depths of 0.00 (green line), and at 0.25, 0.5, 1.0, 1.5 and 2.0 m depths using the green line elevation as reference point. Conductivity sampling performed in the fall to coincide with low river stage (refer to Figure 4-3).	Suggested primary and secondary locations based on reconnaissance, conductivity measurements and professional judgment. Water samples collected at the sediment/water interface along the study area shoreline and where practical, into deeper water along the shoreline. Fall sampling assures that biota are collected below the "green line" and have not been influenced by river level fluctuation.
Drive point water sampling or multiple level sampling (MLS)	Determine interstitial mixing of groundwater and river water.	Seep groundwater below sediment/water interface	Stratified sampling along transects. Specific sampling locations based upon information and decisions made during reconnaissance and conductivity surveys. Collect up to five samples (to a depth of at least 0.3 m) along primary transects (or 10-cm increments to 1.0-m depth for MLS). Consider sampling along intermittent seep transects based upon river water conductivity surveys.	Sampling along primary and intermittent seep transects captures hyporheic flow of mixed groundwater and river water. Sampling at intermittent seep transects and MLS based on professional judgment. Spatial relationship to former outfall structures. Samples will be analyzed for Table 1-10 contaminants.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Sediment sampling in or adjacent to seeps	Determine contaminant concentrations in sediments adjacent to seeps.	Riverbed sediments adjacent to seeps; clays to coarse sands (Substrate #1)	Stratified sampling. Specific locations based upon information and decisions made during reconnaissance and conductivity surveys. Based on availability of sediment.	Sampling along primary and intermittent seep transects for sediments near groundwater emergence into the river. Sampling at intermittent seep transects based on best professional judgment. Substrate type will determine the dominant type of biota in a certain location and help define key characteristics of reference locations. Samples will be analyzed for Table 1-10 contaminants.
River water sampling	Determine contaminant concentrations in river water.	River water column grab sample	Stratified sampling with transects. Specific locations based upon information and decisions made during reconnaissance and conductivity surveys. Collect grab samples along transect lines within the water column immediately above the river bottom.	Sampling along primary and secondary transects for river water near groundwater emergence into the river. Sampling at secondary transects based on best professional judgment. Conservative measure of water quality in the river bottom-mixing zone created by groundwater upwelling. Samples will be analyzed for Table 1-10 contaminants, pH, conductivity, and dissolved oxygen.
River shore radiological surveys	Determine radiological exposure along river shoreline.	Riverbed shoreline	Whole-body radiological surveys performed from a boat along shoreline. Reconnaissance of existing surveys and thermoluminescent dosimetry installations.	Provides dose rate measurements in μR/hr (input to human health exposure scenarios for recreational boater).

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Near-Shore River Biota				
Biota sampling	Determine radioactive and chemical exposure to species, provide screening-level assessment of biota health. Determine spatial extent of near-shore areas with "elevated exposure" scenarios.	Sculpin (vertebrates)	Specific locations along transects (linked to reconnaissance and conductivity surveys). Stratified sampling for resident species in the near-shore river environment. Number of samples to meet analytical mass requirements and/or statistical data needs. Captures biological health metrics based on screening-level assessments.	Sculpin represents closest fit to aquatic vertebrate predator guild. Satisfies sentinel organism criteria. Samples will be analyzed for Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2.
		Crayfish, clams, mayfly, caddisfly (invertebrates)	Specific locations based upon information and decisions made during reconnaissance and conductivity surveys. Default to opportunistic sampling based on professional judgment and availability of biota (coincident sediment samples will also be taken based on availability at default biota sampling locations). Stratified sampling for resident species in the 100-B/C Area. Number of samples to meet analytical mass requirements and/or statistical data needs. Captures biological health metrics based on screening-level assessments.	Aquatic invertebrate represents benthic (corresponds to "soil biota") guild. Satisfies sentinel organism criteria. Samples will be analyzed for Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2. Adult mayfly and caddis fly – contaminant concentrations are indicative of aquatic contaminant exposure.
		Milfoil (macrophytes) Potentially sample periphyton/algae		Aquatic plant guild. Satisfies sentinel organism criteria. Samples will be analyzed for Table 1-10 contaminants and as appropriate, biological health metrics in accordance with Table 3-2.

Table 7-4. Sampling Design Methodology, Objectives, Features, and Basis. (10 Pages)

Sample Collection Methodology	Sampling Objectives	Population	Key Features of Design	Basis for Sampling Design
Near-Shore River Reference Area Biota				
Biota sampling	Duplicate near-shore riverine biota sampling in reference area (to be identified) for comparison with the 100-B/C study area.	Same as near-shore riverine biota	Same as near-shore riverine biota (includes sediment sampling).	Same as near-shore riverine biota.
Upland, Riparian, Near-Shore River Areas				
Long-term monitoring	Verify long-term human health and ecological protectiveness.	Abiotic and biotic sampling populations	Visual observations and specific sampling and analyses (TBD).	A multi-year sampling approach assures collection of data to identify adverse impacts to human and ecological receptors.

TBD = to be determined
GPS = global positioning system
MLS = multiple level sampling

7.3.1.1 Near-Shore River Soil Sampling Adjacent to Seeps. Near-shore river sampling locations will be based upon the known locations of existing seeps and conductivity surveys. Table 7-5 describes the locations of the seeps recorded along the 100-B/C shoreline.

Table 7-5. Existing and Proposed 100-B/C Seeps, Locations, and Status.

Seep #	Location	Status
SB-037-1	Approximately 75 m (246 ft) upriver from the 100-B/C Area intake structure	This is a surveyed location that has a number of active riverbank springs that have been sampled routinely by the Hanford Site Environmental Surveillance Project since 1993. These riverbanks springs have consistent and predictable flows when the river discharge is below 70,000 cfs. Aquifer drive points have been installed at this location.
SB-038-3	Approximately 75 m (246 ft) upriver from the 100-B/C Area intake structure	
SB-039-2	Approximately 75 m (246 ft) down-river from the 100-B/C Area intake structure	This is a surveyed location that has an active riverbank spring. However, the flow is highly influenced by river stage and is frequently not observed flowing at time periods when other riverbank springs (SB-037-1 and SB-038-3 are flowing. The Hanford Site Environmental Surveillance Project has periodically sampled this riverbank spring. Aquifer drive points have been installed at this location.
100-B/C area outfall	Approximately 600 m (1,969 ft) downriver from the 100-B/C Area intake structure	This is a surveyed location that has some small riverbank springs that appear to be influenced by river stage. However, the Hanford Site Environmental Surveillance Project has not collected riverbank spring samples at this location. Aquifer drive points have been installed at this location.
3-4		This is an intermittent seep location that will be verified.
041-1		This is an intermittent seep location that will be verified.
4-1		This is an intermittent seep location that will be verified.
4-2		This is an intermittent seep location that will be verified.
Downriver control	Downriver from the 100-B/C Area and upriver from the 100-K Area.	This is a proposed location, the purpose of which is to collect samples from a down-river area outside the influence of the 100-B/C Area contaminants. Some riverbank springs samples have been collected near the concrete irrigation structure (pre-Hanford Site) located upriver from the 100-K intake structure. Aquifer drive points may be available at this location.

7.3.1.2 Selection of Biotic Samples. Once biological systems are stratified, key environmental entities (species/guilds/assemblages) and attributes (mortality/growth/production) can be identified and sampled. This section provides a framework for evaluating organisms and their attributes to be used for impact assessments as well as long term monitoring. To further define those species, a prioritization process was used. The process involved use of the best available literature, databases, and professional judgment to select species for use in contaminant surveillance and impact assessments. As new data becomes available, the species lists may be modified.

7.3.1.3 Sentinel and Indicator Species Prioritization Process. The ability of organisms to accumulate and concentrate pollutants from the aquatic environment into their bodies has been known for sometime. However, the practical utility of biota as a contaminant surveillance tool was only widely recognized in the 1960s when low concentrations of radionuclides present in seawater limited the ability to detect ambient levels, but sampling and analyzing bi-valve organisms allowed for identification of areas with elevated levels of radionuclides (Phillips and Segar 1986). Biological monitoring can be generally split into two disciplines: (1) biological surveillance to detect the presence and relative abundance of contaminants in a given ecosystem, and (2) monitoring to detect biological indicators of damage or injury to the system induced by elevated levels of contamination.

7.3.1.4 Technical Criteria for Sentinel/Indicator Biota. Sentinel and indicator organisms are useful to provide information on the presence of contamination as well as resulting injuries or impacts. Organisms that bioaccumulate contaminants are well suited for a biological surveillance program and are termed "sentinel species." Sentinel species are advantageous for monitoring because they provide a time-integrated measure of the contaminant bioavailability (Johnson et al. 1993). "Indicator species" are those organisms or entities (or defined assemblages of organisms) that are sensitive to elevated levels of contaminants in the environment and have measurable "end-points" or attributes. These attributes are manifestations of injury that may be critical to individual or population-level survival, such as healthy organs and tissues, growth rates, survival rates, and recruitment rates. In practice, the desirable features of both the sentinel and indicator species are often found only in a limited number of organisms present in the environment. Organisms chosen for biological monitoring should represent the best combination of sentinel and indicator species features. The "ideal" indicator and/or sentinel species should have the following characteristics (Johnson et al. 1993):

- Easy to recognize (no taxonomic uncertainties) and collect
- Relatively narrow ecological demands
- Long-lived
- Widespread enough to facilitate comparisons among different areas
- Large enough or dense enough to provide sufficient tissue for analysis (abundance)
- Sedentary or limited mobility so findings relate to the area being studied (duration of time exposed to the areas)
- Life history traits are well known
- Hardy (suitable for laboratory studies or field handling).

In addition the "ideal" sentinel species should also have a high tolerance for high levels of the pollutant and should show the same simple correlation between their pollutant content and the average pollutant concentration in the environment, at all locations and under all conditions (contaminant pathway).

7.3.1.5 Species Considered for Sampling. There are a number of species that may not score well using the technical approach, however they are important to include in this evaluation because they may have public, cultural, or regulatory significance.

A variety of organisms/plant-animal assemblages have been recognized by state or Federal agencies as threatened or endangered or are element occurrences (Neitzel 2002). These entities may represent organisms that may be more susceptible to adverse population-level anthropogenic impacts. In addition, WAC 173-340 emphasizes consideration of species protected under applicable state or Federal laws when selecting sentinel/indicator species.

Element occurrences and data on other natural resources are maintained as part of the PSRPP's biological resources databases. These data sets will be used to spatially depict element occurrences as defined by Washington State, as well as relative resource values described in the *Hanford Site Biological Resources Management Plan* (DOE-RL 2001c).

The PSRPP's biological resources database along with other biological resource documents (DOE-RL 2001c, Neitzel 2002, Landeen et al. 1993) contain lists of species that occur within the boundary of the pilot study. Using the criteria for indicator and sentinel species selection (discussed above) and the feeding guild approach of WAC 173-340-7490 through -7494, organisms that have been documented to occur within the 100-B/C Area pilot study boundary were evaluated for inclusion in the sampling design. The species selected are included in Table 7-4. One of the most important criteria that must be considered in selecting a species for sampling is that it must be abundant enough to provide sufficient tissue for analysis. Some special interest species do not occur with sufficient abundance and would not be practical to sample. Other species (e.g., top predators or species that are highly mobile) are not likely to accumulate significant concentrations of contaminants from areas smaller than their natural territories; therefore, they were not included in the first round of sampling.

Sampling will involve a tiered approach, beginning with the selected indicator species. If measurement endpoints indicate a potential for unacceptable risk to indicator species, additional sampling may be elected to evaluate accumulation and risk to species with regulatory or cultural significance.

8.0 OBSERVATIONS, RECOMMENDATIONS, AND COMMITMENTS

1. John Price made a requirement during the interview with Ecology that the burial ground stratified sampling results be incorporated into the ecological risk calculations. This is not applicable to the pilot study sampling design but will be carried into the risk assessment when burial ground CVP sampling data are available.

2. The scope of the pilot study is restricted to the 100-B/C shoreline and an appropriate upstream reference location(s). A downstream reference location between 100-K and 100-B/C Areas was also considered (as supported by plume configurations). The following points are noteworthy:

   - Most of the radioactivity that entered the Columbia River from Hanford Site operations has been washed downstream and is no longer present in the reach.

   - Most radionuclides released to the Columbia River (between 1944 and 1971) have accumulated in the deep sediments behind McNary Dam and other dams located downstream (Robertson and Fix 1977).

   - Current monitoring data of radionuclides in the sediments suggests the majority of activity from Hanford is associated in the sediments found in impoundments downstream of the Hanford Site with the majority of material associated with McNary Dam sediments (Robertson and Fix 1977, Poston et al. 2002).

   - The annual spring run-off typically contributes to suspension and downstream transport of sediments from the Hanford Reach.

   - Ongoing sediment deposition has buried these original deposits and much of the original activity has decayed.

   - Some minor level of sediment radioactivity has been retained in Hanford Reach sloughs located downstream of the reactor areas.

   - The levels presently monitored in the Hanford Reach slough sediments arise from both atmospheric fallout and recent releases to the Columbia River from groundwater seepage. It is not possible to trace the source of radioactivity in slough sediments back to specific reactor areas.

   - The slough areas may be specifically addressed in a comprehensive assessment of the entire reach in the future.

   - Atmospheric fallout is a significant contributor to sediment radioactivity in the reach and behind McNary Dam.

The commitments that were made, but not fulfilled in this DQO summary report, were compiled and are presented in Table 8-1.

Table 8-1. DQO Summary Report Commitments.

Commitment #	DQO Report Text Section	Commitment
1	Section 1.6, 10th bullet	Native American subsistence and avid recreationalist exposure scenarios will be evaluated and developed in the future.
2	Table 1-4, item 11i	Pilot study timeframes (0 to 150, 150 to 500, 500+ years) will be developed as the pilot study proceeds.
3	Table 1-4, item 42	A site-specific cultural resource review will be performed for the Columbia River shoreline before ecological sampling is initiated.
4	Table 1-4, item 52	Ecological receptors will be evaluated from a complete species list (includes native) for characterization in the pilot study.
5	Section 1.5.2, global issue #3	Future exposures from groundwater assessed by the pilot study will be addressed by the Groundwater Project.
6	Table 1-13, item 3	Native American exposure scenarios will be addressed by the pilot study.
7	Table 4-4, third row	A multi-year sampling approach may be required to collect adequate data to demonstrate adverse impacts to ecological receptors.
8	Section 8.0, item 1	Burial ground stratified sampling results will be incorporated into the ecological risk calculations. This is not applicable to the pilot study sampling design but will be carried into the risk assessment when burial ground CVP sampling data are available.

9.0 REFERENCES

43 CFR 11, "Natural Resource Damage Assessments," *Code of Federal Regulations*, as amended.

58 FR 48509, "Record of Decision: Decommissioning of Eight Surplus Production Reactors at the Hanford Site," Final Rule, *Federal Register*, Vol. 64, pp. 61615, November 12, 1999.

ANL, 2002, *RESRAD for Windows*, Version 6.21, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois.

BHI, 1996a, *Ecological Resources Review for Remedial Action for 100 B/C Group 1 Waste Sties (96-ER-017)*, CCN 030671, dated April 22, 1996, interoffice memorandum from D. D. Teel to K. R. Myers, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1996b, *Ecological Review for Temporary Office Installation at 100-C (96-ER-028)*, CCN 034917, dated July 22, 1996, interoffice memorandum from D. D. Teel to T. B. Logan, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1997, *Ecological and Cultural Resource Review for 190-C Backfill (97-ER-036)*, CCN 047913, dated June 27, 1997, interoffice memorandum from D. D. Teel to S. M. Hamblin, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998a, *100 Area River Effluent Pipelines Risk Assessment*, BHI-01141, Rev. 0, Bechtel Hanford Inc., Richland, Washington.

BHI, 1998b, *Ecological and Cultural Review of Small Waste Sites at 100-B/C Area (89-ER-032)*, CCN 061037, dated August 19, 1998, interoffice memorandum from D. D. Teel to J. R. Berkey, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000a, *Ecological Resource Review for 100 B/C Area Burial Ground Remediation (00-ER-038)*, CCN 083474, dated October 30, 2000, interoffice memorandum from D. D. Teel to J. D. Ludowise, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Ecological Review for 100 B/C Area Pipeline and Outfall Remediation (00-ER-048)*, CCN 084902, dated December 20, 2000, interoffice memorandum from D. D. Teel to R. D. Beldon and D. N. Strom, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000c, *Ecological Review of Reactor Outfall Removals (00-ER-007)*, CCN 077185, dated March 20, 2000, interoffice memorandum from D. D. Teel to K. E. Cook, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

Carpenter, R. W., 1994, *100-B Area Technical Baseline Report*, WHC-SD-TI-220, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

Doctor, P. G., K. A. Gano, and M. H. Sturges, 2002, *A Preliminary Evaluation of Post-Remediation Protectiveness of Humans and the Environment at the 100-B/C Area*, BHI-01669, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

DOE, 1992, *Decommissioning of Eight Surplus Production Reactors at Hanford Site Addendum*, DOE/EIS-0119F, U.S. Department of Energy, Washington D.C.

DOE, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, DOE/EIS-0222-F, U.S. Department of Energy, Washington, D.C.

DOE, 2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, DOE-STD-1153-2002, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1994a, *Limited Field Investigation Report for the 100-BC-1 Operable Unit*, DOE/RL-93-06, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994b, *Limited Field Investigation Report for the 100-BC-2 Operable Unit*, DOE/RL-94-42, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994c, *Limited Field Investigation Report for the 100-BC-5 Operable Unit*, DOE/RL-93-37, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998, *Columbia River Comprehensive Impact Assessment*, DOE/RL-96-16, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001a, *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-35, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001b, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001c, *Hanford Site Biological Resources Management Plan*, DOE/RL-96-32, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Downs, J. L., W. H. Rickard, C. A. Brandt, L. L. Cadwell, C. E. Cushing, D. R. Geist, R. M. Mazaika, D. A. Neitzel, L. E. Rogers, M. R. Sackschewsky, and J. J. Nugent, 1993, *Habitat Types on the Hanford Site: Wildlife and Plant Species of Concern*, PNL-8942, Pacific Northwest Laboratory, Richland, Washington.

Duratek, 2002, *Hanford Site Biotic Database*, Duratek Federal Services of Hanford, Inc., Richland, Washington.

Ecology, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Publication #94-115, Washington State Department of Ecology, Olympia, Washington.

Ecology, EPA, and DOE, 1998, *Hanford Federal Facility Agreement and Consent Order*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland, Washington.

Endangered Species Act of 1973, 16 U.S.C. 1531, et seq.

EPA, 1994, *Guidance Manual for the Integrated Exposure Uptake Biokenetic Model for Lead in Children*, EPA/540/R-93/081, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1997, *Ecological Assessment Guidance for Superfund – Process for Designing and Conducting Ecological Risk Assessments*, EPA/540/R-97/006, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1998, *Guidelines for Ecological Risk Assessment*, EPA/630/R-95/002F, U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, D.C.

EPA, 2001, *ECO Update, The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*, EPA/540/F-01/014, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, Ecology, and DOE, 1995, *Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

Gano, K. A., and J. B. States, 1984, *Habitat Requirements and Burrowing Depths of Rodents in Relation to Shallow Waste Burial Sites*, PNL-4140, Pacific Northwest Laboratory, Richland, Washington.

Johnson, O. K., Wiederholm, T., and D. M. Rosenberg, 1993, "Freshwater Biomonitoring Using Individual Organisms, Populations, and Species Assemblages of Benthic Macroinvertebrates," in *Freshwater Biomonitoring and Benthic Macroinvertebrates*, D. M. Rosenberg and V. H. Resh, eds. Pp. 40-158, Chapman and Hall, London, England.

Klepper, E. L., K. A. Gano, and L. L. Cadwell, 1985, *Rooting Depth and Distributions of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site*, PNL-5247, Pacific Northwest Laboratory, Richland, Washington.

Landeen, D. S., M. R. Sackschewsky, and S. Weiss, 1993, *100 Areas CERCLA Ecological Investigations*, WHC-EP-0620, Westinghouse Hanford Company, Richland, Washington.

Migratory Bird Treaty Act, 16 U.S.C. 703, et seq.

National Environmental Policy Act of 1969, 42 U.S.C. 4321, et seq.

Neitzel, D. A. (ed.), 2002, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNNL-6415, Rev. 14, Pacific Northwest National Laboratory, Richland, Washington.

Patton, G. W., S. P. Van Verst, B. L. Tiller, E. J. Antonio, and T. M. Poston, 2002, *Survey of Radiological and Chemical Contaminants in the Near-Shore Environment at the Hanford Site 300 Area*, PNNL-13692, Pacific Northwest National Laboratory, Richland Washington.

Peterson, R. E., and M. P. Connelly, 2001, *Zone of Interaction Between Hanford Site Groundwater and Adjacent Columbia River*, PNNL-13674, Pacific Northwest National Laboratory, Richland, Washington.

Phillips, D. J. H., and D. A. Segar, 1986, "Use of Bio-Indicators in Monitoring Conservative Contaminants: Programee Design Imperatives," *Marine Pollution Bulletin*, 17:10-7.

PNL, 1993, *Radiological Survey of Shoreline Vegetation from the Hanford Reach of the Columbia River, 1990-1992*, PNL-8797, Pacific Northwest Laboratory, Richland, Washington.

PNNL, 2000a, *Hanford Site Environmental Report for Calendar Year 1999*, PNNL-13230, Pacific Northwest National Laboratory, Richland, Washington.

PNNL, 2000b, *Surface Environmental Surveillance Procedures Manual*, PNL-MA-580, Rev. 3, Pacific Northwest National Laboratory, Richland, Washington.

PNNL, 2002, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*, PNNL-13788, Pacific Northwest National Laboratory, Richland, Washington.

Poston, T. M., R. W. Hanf, R. L. Dirkes, and L. F. Morasch (eds.), 2002, *Hanford Site Environmental Report for Calendar Year 2001*, PNNL-13910, Pacific Northwest National Laboratory, Richland, Washington.

Reiman, R. T., and T. S. Dahlstrom, 1990, *An Aerial Radiological Survey of the Hanford Site and Surrounding Area*, EGG-10617-1062, EG&G Energy Measurements, Remote Sensing Laboratory, Springfield, Virginia.

Robertson, D. E., and J. J. Fix, 1977, *Association of Hanford Origin Radionuclides With Columbia River Sediment*, BNWL-2305, Pacific Northwest Laboratory, Richland, Washington.

Sackschewsky, M. R., 1992, *Biological Assessment for Rare and Endangered Plant Species Related to CERCLA Characterization Activities*, WHC-EP-0526, Westinghouse Hanford Company, Richland, Washington.

Sackschewsky, M. R., and D. S. Landeen, 1992, *Fiscal Year 1991 100 Areas CERCLA Ecological Investigations*, WHC-EP-0448, Westinghouse Hanford Company, Richland, Washington.

Sackschewsky, M. R., and J. L. Downs, 2001, *Vascular Plants of the Hanford Site*, PNNL-13688, Pacific Northwest National Laboratory, Richland, Washington.

Safe Drinking Water Act of 1974, 42 U.S.C. 300, et seq.

TNC, 1999, *Biodiversity Inventory and Analysis of the Hanford Site, Final Report 1994-1999*, The Nature Conservancy of Washington, Seattle, Washington.

Van Verst, S. P., C. L. Albin, G. W. Patton, M. L. Blanton, T. M. Poston, A. T. Cooper, and E. J. Antonio, 1998, *Survey of Radiological Contaminants in the Near-Shore Environment at the Hanford Site 100-N Reactor Area*, PNNL-11933, Pacific Northwest National Laboratory and the Washington State Department of Health, Richland, Washington.

WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended.

WAC 173-340-704, "Use of Method A," *Washington Administrative Code*, as amended.

WAC 173-340-705, "Use of Method B," *Washington Administrative Code*, as amended.

WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," *Washington Administrative Code*, as amended.

WAC 173-340-900, "Model Toxics Control Act – Cleanup, Tables" *Washington Administrative Code*, as amended.

WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures," *Washington Administrative Code*, as amended.

WAC 173-340-7491, "Exclusions From a Terrestrial Ecological Evaluation," *Washington Administrative Code*, as amended.

WAC 173-340-7492, "Simplified Terrestrial Ecological Evaluation Procedures," *Washington Administrative Code*, as amended.

WAC 173-340-7493, "Site-Specific Terrestrial Ecological Evaluation Procedures," *Washington Administrative Code*, as amended.

Weiss, S. G., and R. M. Mitchell, 1992, *A Synthesis of Ecological Data from the 100 Areas of the Hanford Site*, WHC-EP-0601, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

ISSUES IDENTIFIED BY NATURAL RESOURCE TRUSTEES AND THE HANFORD ADVISORY BOARD

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#		Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
Political								
1.		Use team approach with USFWS for setting standards		X				
2.		Discuss management of the monument with USF&W at the regional level, not just the local level				X		
3.		Uses of land under "Monument"					X	
4.		Risk assessment process						
	a.	List known toxicity impacts/mechanisms/effects of COCs to Ecological receptors.				X		
	b.	Integrate eight-step EPA risk assessment methodology with new WAC 173-340-7490 ecological evaluation procedures and include site-specific sampling.				X		
	c.	Define ecological assessment and measurement end-points, i.e., look for health of the aquatic environment using some measurement endpoints defined by expert team (USFWS and NMFS).				X		
5.		Experimental information is needed to fill data gaps					X	
6.		Use a holistic evaluation process		X				
7.		Discuss public involvement					X	
Protectiveness								
8.		Need for Native American exposure scenarios						
	a.	Protectiveness for Native American use and treaty rights			X	X		X
	b.	Herb sites			X	X		
	c.	Vegetation – food			X	X		
	d.	Vegetation – medicine			X	X		
	e.	Culturally sensitive areas			X	X		
	f.	Long-term effect of radionuclides on Native American lifestyle				X		
	g.	Spring water sources for Sweat Lodges						X
	h.	Fish consumption						X
	i.	Evaluate treaty protected species			X			
	j.	Native American use categories				X		X

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#		Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
	k.	River use and associated consumption (include women and children)				X	X	X
	l.	Protection of human health and ecological receptors now and for future generations					X	X
	m.	Evaluate Native American exposure pathways by others (tank retrieval performance evaluation study by Jacobs Engineering)				X		
9.		Recreational scenario (Monument access, camping, shoreline use; include children, recreational worker, and unique child dose response)					X	
10.		Use MTCA human health risk assumptions					X	
11.		Assumptions						
	a.	Define boundary of the assessment and address the entire area within boundary including portions not remediated				X		
	b.	Define groundwater use					X	
	c.	Catastrophic river flood					X	
	d.	Constrain the project to credible events					X	
	e.	Determine ecological risk for upland, riparian, and near-shore aquatic zones					X	
	f.	• Evaluate certain sites/areas in risk evaluation • Liquid waste discharge sites • Leaks along pipelines • Seeps • Residual Tritium from targets • Burial ground wastes and capsules • "Hot spots" (site should be characterized).			X	X		
	g.	Residual contamination; unused areas (airborne deposits)				X		
	h.	Overland flows from operational upsets				X		

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#		Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
	i.	• Define terms in the pilot study DQO • Timeframes (0-150, 150-500, 500+ yrs) • Zones • Reference case • Monument					X	
12.	Global issues							
	a.	Future groundwater impacts from 200 Areas.					X	
	b.	Long-term stewardship.					X	
	c.	15 mrem/yr radiological criteria are not conservative enough.						X
	d.	95% UCL not adequate for Native American scenario.						X
	e.	Legal recourse for natural resource damages through NRDA.						X
	f.	Ensure that contaminated soils beneath reactor buildings will be addressed after remediation.			X			X
	g.	EPA "hot spot" size not appropriate for Native American uses.						X
13.	For ecological protectiveness, use site specific cleanup criteria for COC elimination, not only MTCA tables			X				
Ecological RAGs								
14.	Ecological RAGs							
	a.	Revisit process for setting ecological RAGs		X			X	
	b.	Evaluate AWQC for protection of all aquatic species		X				
Pathways								
15.	Use shrub/steppe habitat assessment for uplands						X	
16.	Include groundwater		X	X	X	X	X	
	a.	Assess commingling of groundwater plumes.				X		
	b.	Evaluate groundwater contamination/mobility/recharge pathways.		X	X		X	
	c.	Evaluate deep zone COCs and mobility/pathways.		X	X			X

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#	Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
	d. Assess underground waste/plumes from B and C Reactor FSB leakage.			X	X		
	e. Characterize elevated water mounds in vadose zone.						X
	f. Distribution coefficients used may not represent observed behavior in the soils (e.g., chromium VI).				X		
17.	DOE should maintain the ability to re-address deep contamination if new treatment technologies are developed to address deep zone and groundwater impacts				X		
18.	Evaluate pathways for contamination to biota		X			X	X
19.	Address potential exposure pathways to ecological receptors (birds, through unsealed structures; include main facilities and B Reactor stack)			X			
20.	Address plant, animal, or insect intrusion into waste sites and facilities (e.g., badgers, ants, gnats, flies, bird nesting materials, snakes, mice, other rodents, and burrowing owls, sagebrush and Russian thistle)			X			
21.	State that the major impact of groundwater is at the shoreline					X	
River							
22.	Changes in river quality and sediment loading from upstream over time		X			X	
23.	Evaluate river pipelines as a potential source and pathway to aquatic receptors; europium concern			X			
24.	Balance aquatic protection for pipeline removal vs. no-action					X	
25.	Evaluate salmonid and other anadromous receptor risks:					X	
	a. Beyond site boundary		X				
	b. COC accumulation in downstream sediments		X				
	c. Incremental risk within Hanford Reach						X
26.	Evaluate entire river in risk assessment (cumulative for all reactor operations areas, not just for 100-B/C Area)			X		X	
27.	River contamination conditions						
	a. Evaluate conditions downstream of releases on both shorelines.			X			
28.	River stage change/contaminant mobility/pathways		X	X			

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#	Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
29.	Evaluate surface water run-off and stream pathways to river (past and present)		X				
30.	Characterize river sediments for fuel COCs; develop comprehensive summary			X		X	
31.	The river needs to be characterized for contaminants				X		
Models							
32.	Current groundwater/vadose zone models do not adequately assess COC movement			X			
33.	RESRAD model is not sophisticated and is inadequate for closure of rad contaminated sites; consult EPA guidance				X		
Tribal Issues							
34.	Past treatment of Native Americans and trust issues				X		
35.	Yakama Nation wants involvement with this study and its development through tribal council involvement				X		
36.	CTUIR wants more involvement in revegetation and restoration process						X
37.	Threatened culture						X
Project Technical Issues							
38.	Consider using background values from offsite locations (Columbia Wildlife Refuge) for background values; provide rationale for onsite background values		X				
39.	Seal waste sites and facilities to prevent animal/plant intrusion that results in contaminating the intruders and contamination spread			X			
40.	A conceptual site-wide cause/effect model was presented to ERC; the diagram represents thoughts on conceptual model needs				X		
41.	Roads need to be closed to reduce impacts to ecology and discourage illegal artifact removal						X
42.	Protection of archaeological resources			X			
43.	Review aerial and tractor survey radionuclide results for contamination between waste sites				X		

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#		Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
COCs								
44.		MTCA ecological procedures may not include all contaminants		X				
45.		Investigate pesticides, organic/petroleum COCs from support facilities		X			X	
46.		COC comparison and evaluation						
	a.	Perform a comprehensive COC evaluation for onsite and offsite sources (include airborne sources).				X		
	b.	Identify pathways by comparing COCs detected from biota surveys in the 100-B/C area with the COCs from reactor operations to determine if COCs with biological concern have been omitted				X		
47.		Determine full range of COCs				X		
	a.	Lead		X				
	b.	Hexavalent chromium		X				
	c.	Mercury		X				
	d.	Thorium/thorium oxide		X				
	e.	U-232, U-233		X				
	f.	Cadmium		X				
	g.	Zinc		X				
	h.	Barium		X				
	i.	Arsenic		X				
	j.	PCBs		X				
	k.	Persistent chlorinated materials formerly used as pesticides		X				
	l.	Herbicides		X				
	m.	Rodenticides		X				
	n.	Fungicides		X				
	o.	Full suite of reactor isotopes from fuel and tritium target activities		X				

Table A-1. Issues Identified by Natural Resource Trustees and the Hanford Advisory Board. (8 Pages)

#		Interview Issues	Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
Receptors/Abundance								
48.	Evaluate receptors and their abundance							
	a.	Microbiological receptors	X					
	b.	Reptiles	X	X			X	
	c.	Amphibians		X				
	d.	Badgers		X				
	e.	Gophers		X				
	f.	Harvester ants		X				
	g.	Salmonid/other anadromous species and spawning beds (HAB also wants to consider juveniles, returning adults and young)		X	X		X	
	h.	Eels			X			
	i.	Sturgeon			X			
	j.	Bass and other fish			X			
	k.	Ducks and other river fowl			X			
	l.	Deer, coyotes, otter, beaver and other transients			X			
49.	Establish feeding guilds						X	
50.	Evaluate all federally listed threatened and endangered species			X	X			
51.	Evaluate *Migratory Bird Treaty Act* species				X			
52.	Characterize ecological receptors from a complete species list (includes native)			X	X	X	X	
53.	Consider previous monitoring and sampling studies (HAB wants EPA study on PCBs in the Columbia River)		X			X	X	
Ecological Sampling								
54.	ID temporal requirements for species sampling						X	
55.	Use of representative species							
	a.	Resident species for ecological sampling to demonstrate protectiveness					X	
	b.	Darkling beetles	X					
	c.	Harvester ants	X					

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#	Interview Issues		Nez Perce	USFWS	OOOE	Yakama Nation	HAB	CTUIR
	d.	Pocket mice	X					
	e.	Plants with long roots	X					
56.	Standard Ecological sampling for receptors in all reactor areas and consistent receptors		X					
57.	Sampling before and after remediation		X					

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